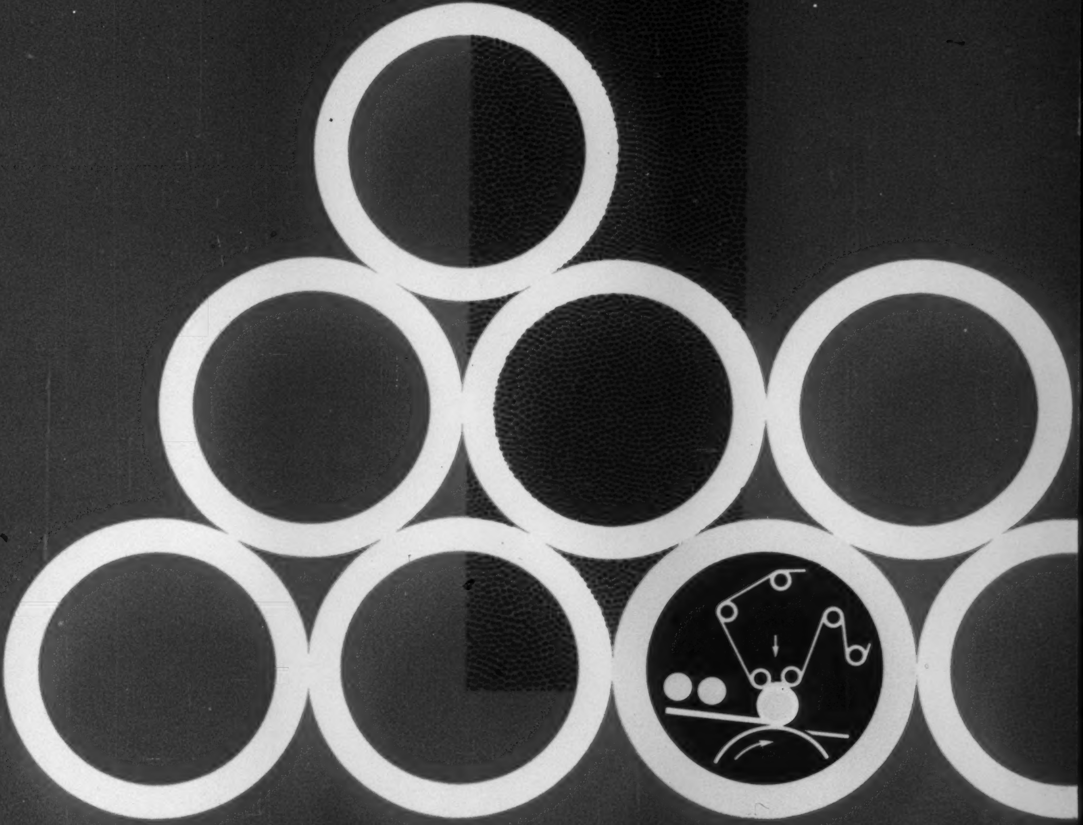
OCTOBER 1960

AUTOMATION



Making Asbestos-Cement Pipe

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- **Management Aspects of Numerical Control**
- **Integrating Case Handling**
- **Applying Automatic Optimizing Control**
- **Floating Fixtures Position Castings**

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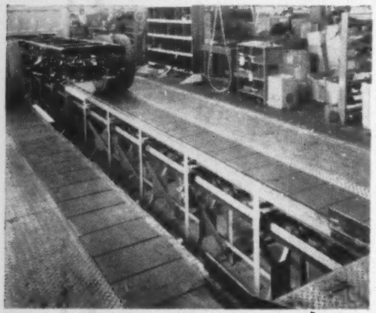
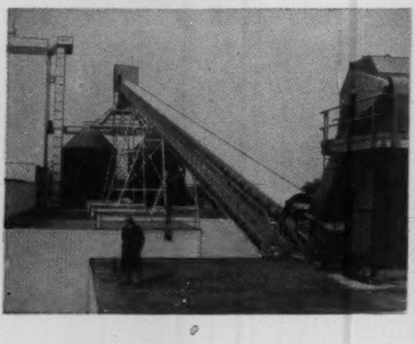
A PENTON PUBLICATION

TRUCK ASSEMBLY SYSTEM



LOG AND CHIP HANDLING SYSTEM



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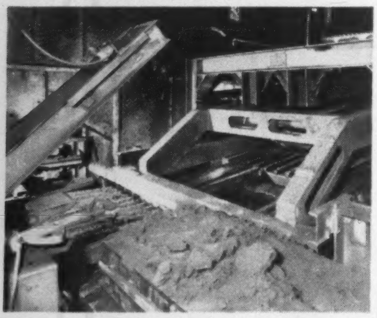

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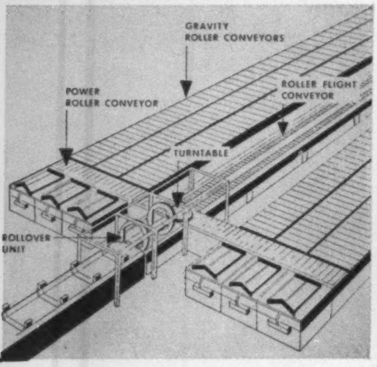

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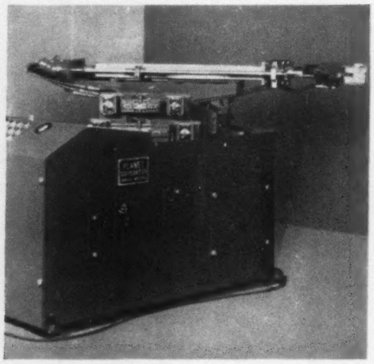

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Circle 651 on Page 19

NEW HEALDRILL

...a high-precision drilling machine designed for fully automatic NUMERICAL CONTROL OF ALL FUNCTIONS

The *completely new* Healdrill offers you, for the first time, a high-precision, heavy-duty layout or production drill that's designed to take full advantage of modern numerical control.

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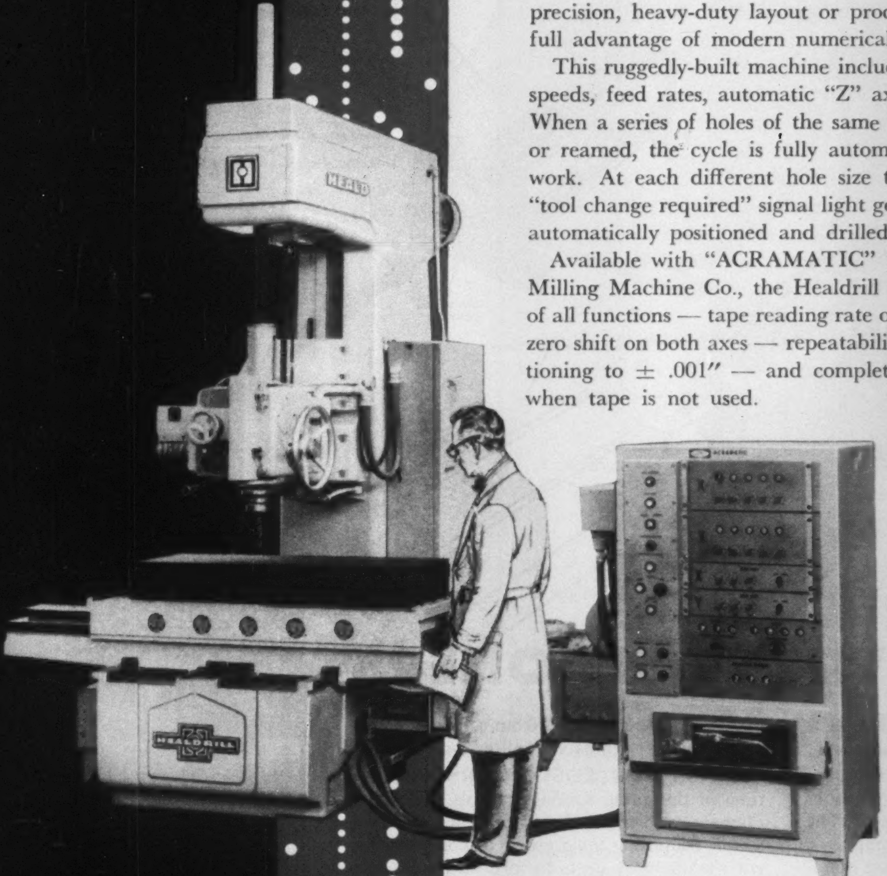
Available with "ACRAMATIC" punched tape control by Cincinnati Milling Machine Co., the Healdrill permits simple, direct programming of all functions — tape reading rate of 1200 lines per minute — full range zero shift on both axes — repeatability of ± .0002″ — accuracy of positioning to ± .001″ — and complete manual control from the console when tape is not used.



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Circle 654 on Page 19

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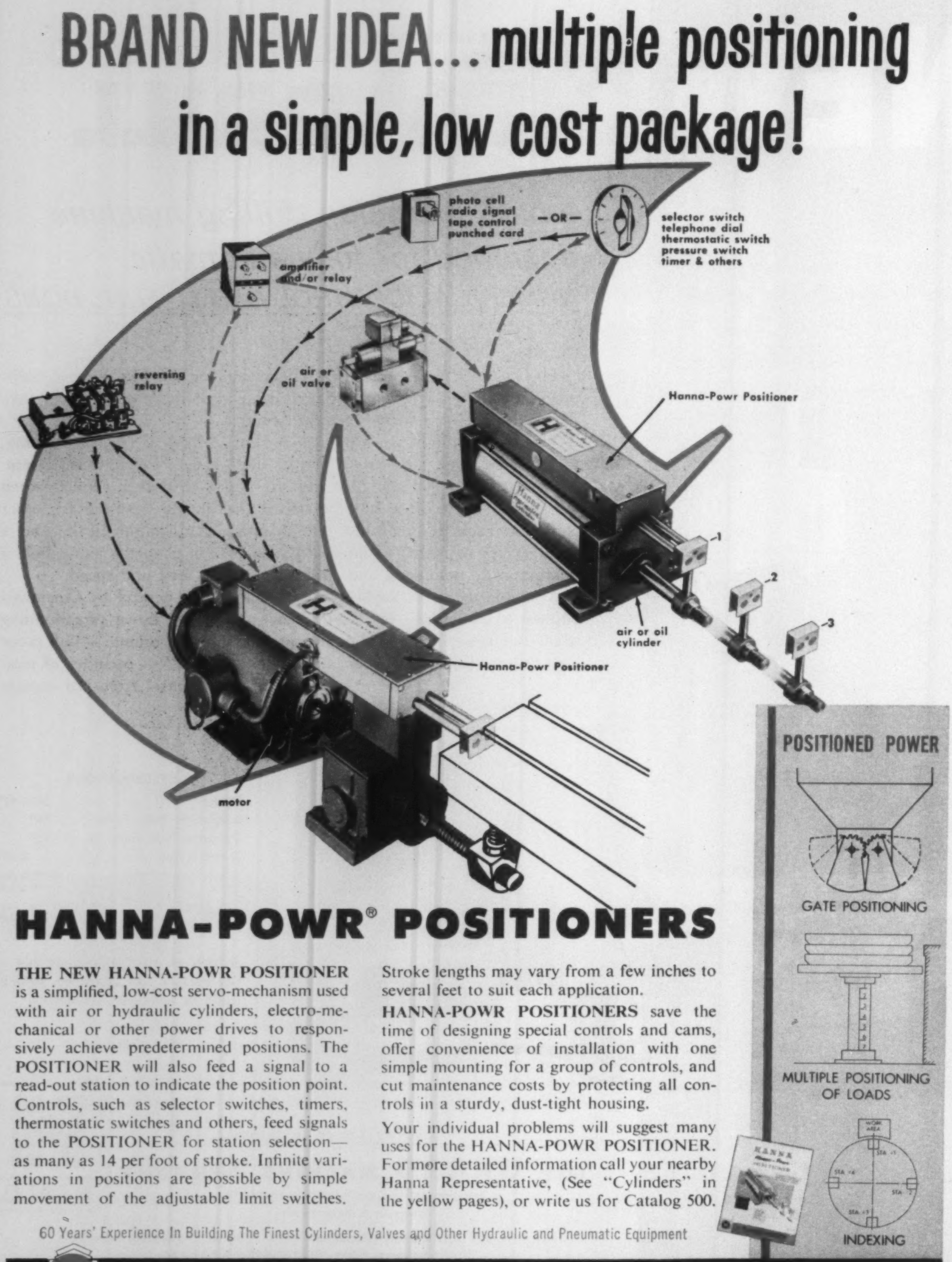
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thermostatic switch
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timer & others
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air or oil valve
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2
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motor
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MULTIPLE POSITIONING OF LOADS
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INDEXING
HANNA

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THE NEW HANNA-POWR POSITIONER is a simplified, low-cost servo-mechanism used with air or hydraulic cylinders, electro-mechanical or other power drives to responsively achieve predetermined positions. The POSITIONER will also feed a signal to a read-out station to indicate the position point. Controls, such as selector switches, timers, thermostatic switches and others, feed signals to the POSITIONER for station selection—as many as 14 per foot of stroke. Infinite variations in positions are possible by simple movement of the adjustable limit switches. Stroke lengths may vary from a few inches to several feet to suit each application.

HANNA-POWR POSITIONERS save the time of designing special controls and cams, offer convenience of installation with one simple mounting for a group of controls, and cut maintenance costs by protecting all controls in a sturdy, dust-tight housing.

Your individual problems will suggest many uses for the HANNA-POWR POSITIONER. For more detailed information call your nearby Hanna Representative, (See "Cylinders" in the yellow pages), or write us for Catalog 500.

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OCTOBER 1960
Vol. 7 — No. 10

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Manufacturing Operations

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automation outlook

SELLERS' VIEWS ON ENGINEERING COSTS

". . . Why not have a standardized engineering fee for line type quotations? . . . costs could be averaged out and a dollar figure assigned to special lines by numbers of active stations and/or operations . . . ."—*J. R. Barefoot, president, Federal Machine and Welder Co., see page 82.*

". . . Industry would get the most out of its engineering for automation if it would buy the design program development concept in which actual engineering hours are billed in process. Then when the design is finalized, the machine could be quoted and built . . . ."—*L. P. Gajda, vice president-engineering, Snyder Corp., see page 84.*

". . . many companies will review their purchasing practices and possibly many machine tool builders will review their proposal practices. We may reach a result which may place machine tool engineering and machine tool proposal work on a basis much similar to that of the architect's place in the building trade . . . ."—*E. L. McFerren, vice president-sales, Giddings & Lewis Machine Tool Co., see page 87.*

". . . in certain heavy industries in Britain, the bidders on large projects enter into an informal gentlemen's agreement, and add a predetermined percentage to their bids . . . The successful bidder upon receipt of a contract would then be obligated to pay each of the . . . unsuccessful bidders an equal share of the amount added to the bid . . . ."—*W. K. Stokes, vice president-sales, Alvey-Ferguson Co., see page 89.*

BORROWED PHILOSOPHY

". . . the present national mail volume of 60 billion pieces a year will double in the next 15 years. Nothing but a whole new philosophy and a whole new set of machines will take care of the increase . . . . the solution of post office volume growth problems must be on a "systems" approach as compared to the piecemeal approach of merely "patching up" difficult situations here and there. We borrowed the "systems approach" from the missile industry. This philosophy has taught us that by solving one problem area, we must definitely be certain not to increase another . . . ."—*A. F. Bruns, manager of customer relations, Atlantic Div., Aerojet-General Corp.*

RESEARCH FOR QUALITY AND YIELD

". . . . at U. S. Steel, the work of the applied research group starts with the study of raw materials, includes blast furnace and open hearth research, and embraces rolling mill practice, products, coal chemicals, heat treatment, and is charged with developing materials with new and improved properties. In this general effort, the new electromechanical laboratories are of special interest because they will be dedicated to the development and application of control systems for new and existing processes in all steelmaking functions and will search for better methods of controlling the chemical and metallurgical properties of our products. We want to do this, first, to obtain ever higher quality, and second, to improve the yield of our mills . . . ."—*J. B. Austin, administrative vice president—research & technology, United States Steel Corp.*

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...Fluid Power news

REPORT
No. 11,302
"ANY-SPEED"
DRIVE
UPS MILL
EFFICIENCY

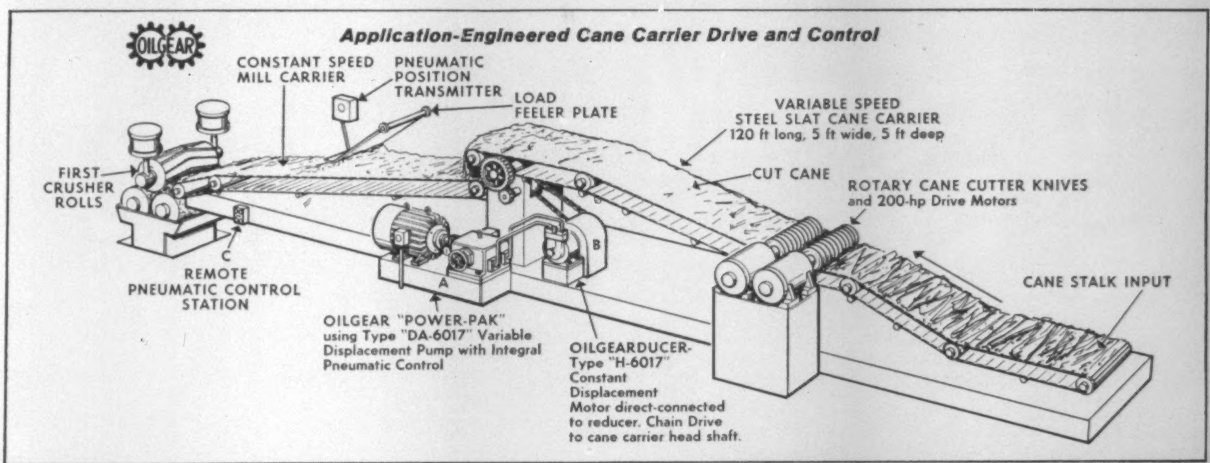
From Oilgear Application-Engineering Files

HOW OILGEAR "Any-Speed" DRIVE AND CONTROL SYSTEM AUTOMATED A SUGAR CANE CARRIER

CUSTOMER: A Large Sugar Cane Mill (Name on request).

DATA: To increase mill efficiency, and run at maximum capacity by maintaining an optimum flow of cut cane to the crushers, it was necessary to convert a conventional, manually controlled electric cane carrier drive to an automatic, load-sensitive, variable speed drive and control system with the following specific requirements: 1. An infinitely variable speed drive coupled with automatic "sensing" load-speed controls to exactly match cutter and crusher capacity . . . plus instant-stop overload protection as required by the following variables: 1a. Inconsistent carrier loading. 1b. Varying size and physical characteristics of the cane. 1c. Cut cane's tendency to "choke" or pile up at the crusher. 1d. Gradual efficiency loss as cutter knives become dull. 2. Automatic speed control, and stop, related to load. 3. Remote and manual control to start, stop, inch, and infinitely increase or decrease carrier speed. 4. Pneumatic controls, as mill personnel understand them. 5. Dependable, trouble-free for round-the-clock harvest operation, impervious to high humidity and daily washdowns.

Application-Engineered Cane Carrier Drive and Control

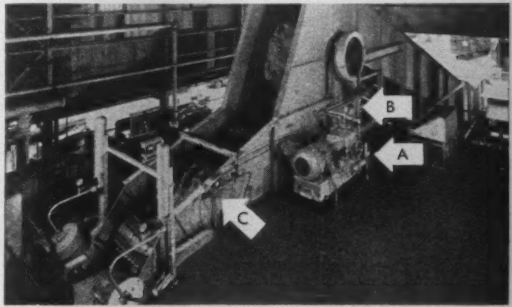

OILGEAR
CONSTANT SPEED MILL CARRIER
PNEUMATIC POSITION TRANSMITTER
LOAD FEELER PLATE
VARIABLE SPEED STEEL SLAT CANE CARRIER 120 ft long, 5 ft wide, 5 ft deep
FIRST CRUSHER ROLLS
CUT CANE
ROTARY CANE CUTTER KNIVES and 200-hp Drive Motors
B
C
REMOTE PNEUMATIC CONTROL STATION
A
CANE STALK INPUT
OILGEAR "POWER-PAK" using Type "DA-6017" Variable Displacement Pump with Integral Pneumatic Control
OILGEARDUCER-Type "H-6017" Constant Displacement Motor direct-connected to reducer. Chain Drive to cane carrier head shaft.

SOLUTION: An Oilgear "Any-Speed" Drive and Control System consisting of an Oilgear "Power-Pak," an Oilgearducer, and the pneumatic control system as shown above. This "Power-Pak" uses a Type "DA" Variable Displacement Pump with integral pneumatic control, a constant speed electric motor all mounted on a custom reservoir base. The Oilgearducer consists of an Oilgear Type "H" Constant Displacement Motor direct-connected to a reducer. Operating on a pressure differential of 3 to 15 psi, the integral, pneumatic, pump control system provides stepless, infinitely variable drive speeds from zero to maximum. A completely automatic control system increases or decreases carrier speed in response to preset percentage of knife motor load, and position of the feeler plate on the mill carrier section . . . carrier is instantly stopped by sudden peak overloads on the knife motors, or by raising of the feeler plate above a preset position. Carrier can also be started, stopped, inched, accelerated or decelerated from the remote stations, or with the manual handwheel on the Pump.

OWNER REPORT — after two seasons of operation — "*. . . . we began operations this season on January 9. We have been running under automatic operation since, and the results have been beyond expectations.*"

Circle 656 on Page 19

Right: A view of above installation. Oilgear "Power-Pak" (A), Oilgearducer (B), and one of the Remote Control Stations (C) are indicated.



Some of the "Plus Features" of this, and other Oilgear installations are: cushioned starts, stops, acceleration and deceleration . . . constant pressure and flood lubrication, and system fluid filtration . . . a "sealed" system, impervious to moisture-hazardous atmosphere . . . complete overload protection . . . long-life, trouble-free, efficient performance. Users say — "*for the lowest cost per year — it's Oilgear!*"

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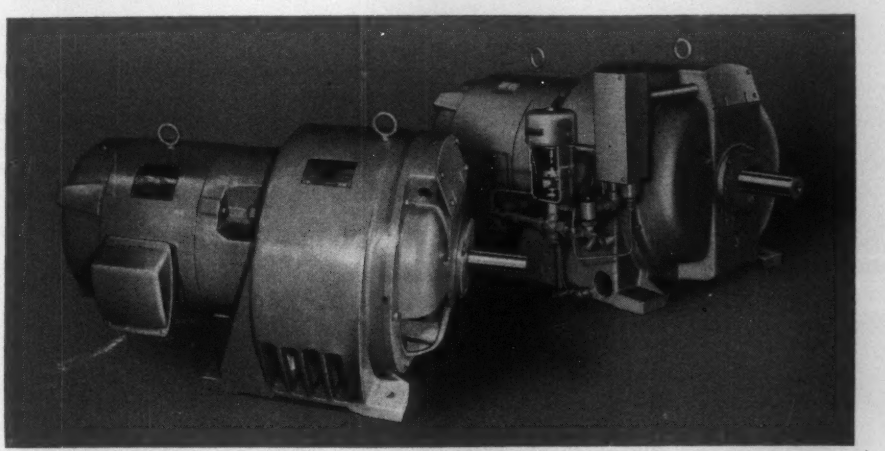
These compact drives, having a minimum number of parts, are built for rough, trouble-free service. The unique electromagnetic coupling maintains adjustable output speed without the use of pulleys, belts, brushes, commutators, slip rings or rotating windings. A rugged Life-Line® "A" motor supplies reliable a-c drive power. No power converting equipment needed—only a small, static exciter and an operator's control station. Initial cost is low; installation—easy and inexpensive.

Your Man from Westinghouse is ready now to help you apply MagnaFlow drives . . . and any other drives you may need. Call him . . . or write for a copy of Westinghouse MagnaFlow Electromagnetic Drives (B-7875), Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse. J-22162

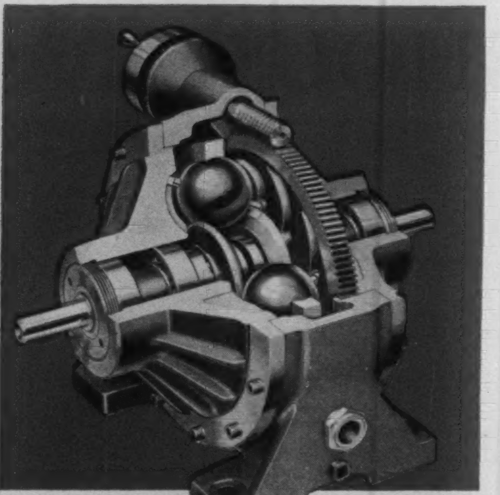
*Trade-Mark

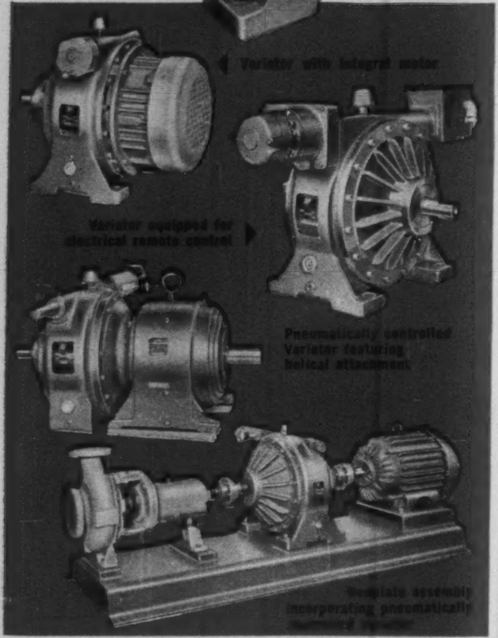


MagnaFlow drives—air cooled (foreground) and liquid cooled—are available in various horsepower ratings for winders, conveyors, fans, pumps, extruders and other machinery in all industries.

Westinghouse

Circle 657 on Page 19




Variator with integral motor
Variator equipped for electrical remote control
Pneumatically controlled Variator featuring helical attachment
Baseplate assembly incorporating pneumatically controlled Variator

for accurate, dependable, infinitely variable speed control, specify...

CLEVELAND SPEED VARIATOR

Cleveland Speed Variators are simple in operation . . . built for long life. Eighteen models—including a new motorized unit—range from fractional to 16 hp at 1750 input RPM. They all accurately provide dependable, infinitely variable speed control over a full 9:1 range—from ⅓ to 3 times input speed. Instant smooth change of output speed can be adjusted by either manual, automatic or remote control. Precise adjustments are always made with accurate adherence to settings.

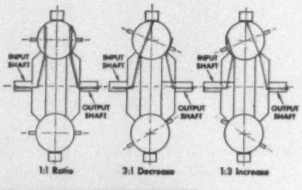
Exclusive Variator advantages:

- An extremely compact unit with input and output shafts in line and rotating in the same direction.
- Almost any input speed up to 1800 RPM can be used—either clockwise or counterclockwise rotation.
- Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant output torque over a 6:1 range.
- Speeds infinitely variable over entire range of adjustment.
- No slippage—positive torque response mechanism adjusts in direct proportion to the loads encountered.
- Long life and minimum maintenance due to absence of belts or complicated linkages.
- Ample bearing support for overhung pulleys on both input and output shafts.

Write today for free Bulletins and Data Sheets shown at left. They contain detailed description, photographs, sectional drawings, rating tables and specifications for the versatile Variator.

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3265 East 80th Street • Cleveland 4, Ohio

Power is transmitted from input shaft to output shaft — rotating in the same direction — through alloy steel driving balls which are in pressure contact with the drive discs. Relative shaft speeds are adjusted by changing position of axles on which the balls rotate.


INPUT SHAFT
OUTPUT SHAFT
INPUT SHAFT
OUTPUT SHAFT
INPUT SHAFT
OUTPUT SHAFT
1:1 Ratio
3:1 Decrease
1:3 Increase

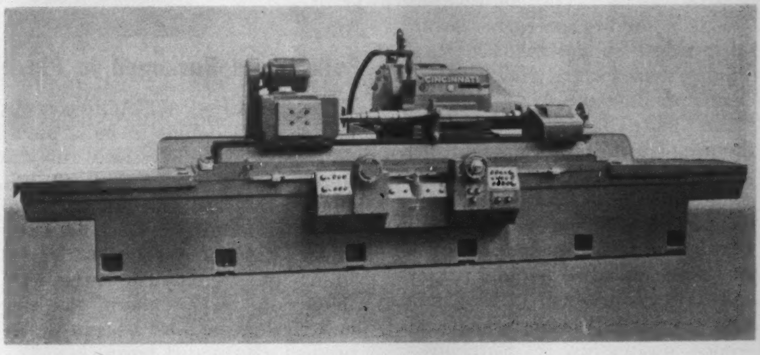
CLEVELAND SPEED VARIATOR

AUTOMATION news

Today's events and developments in the field of automation

Grinding Machine Is Numerically Controlled

CYLINDRICAL grinding machine is equipped with numerical controls by which the sequence and type of operation to be performed, table reversal points, table and wheelhead movements, truing of a predetermined amount from the grinding wheel, and cycle stops may be programmed on punched tape. Designed by the Grinding Machine Div., Cincinnati Milling Machine Co., the unit has a capacity of 18 by 72 inches between centers.



CYLINDRICAL plain grinding machine developed by Cincinnati Milling Machine Co. has a capacity of 18 by 72 inches between centers. Workpiece held in grinding position is a 25 horsepower motor armature shaft, 54½ inches long, that has 10 stepped diameters. All functions of the machine cycle to rough and finish grind this typical part may be programmed on punched tape.

Hydraulic and coolant reservoirs are isolated from the machine bed, thus reducing the possibility of workpiece taper caused by thermal distortion. Special bearings provide rigid mounting for the grinding wheel spindle, and an automatic grinding wheel balancing feature permits the wheel to be balanced on the machine within a few seconds.

The numerical control, designated Acramatic, is a 2-axis, rate controlled positioning type. It is an absolute system based on voltage ratios, therefore variations in line voltage and external signals do not affect the machine performance.

For occasional jobs that do not require the preparation of a numerical tape, the desired diameter can be manually preselected. The operator then presses a *Cycle Start* button, and the diameter is automatically ground to the preset size. The machine can also be used, independent of tape control, for traverse or automatic infeed grinding.

Typical workpieces that can be ground automatically on the machine include large size armature shafts, spindles, and multiple diameter shafts. Both rough and finish grinding may be performed, with numerical control of plunge and traverse grinding operations.

Metalworking Industry To View Technological Advances

TECHNICAL ASPECTS of metals and materials will be highlighted at the 1960 Metal Show (42nd National Metal Congress and Exposition) to be held in Philadelphia Oct. 17-21. Attention will be centered on improving technology in every area of metalworking. An estimated 25,000 visitors are expected to attend the show at Philadelphia's Trade and Convention Center.

Focal point of the exposition, sponsored by the American Society for Metals, will be in the steel arena where there will be a 34-foot high steel structure called a quadrilon. Arrayed about the crossed arches of the quadrilon will be the exhibits of 16 major steel firms. Included in this specialized grouping will be hundreds of samples of steel products for every phase of steel—engineering, production, and marketing.

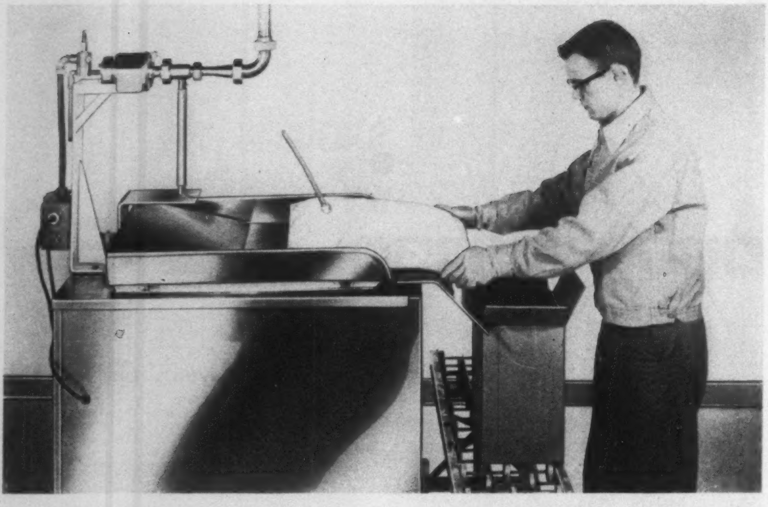
In addition, three other halls at the Convention Center will contain more than 200 exhibits from ten other categories established by the ASM to define sharply the metals personality of this event. These exhibits will provide product and service information on materials, processes, fabrication, and inspection methods.

Automated Handling System To Speed Fleet Supply

MATERIALS handling concept designed to improve the issue of bin-stored fleet supply items through automation will be extended to the Naval Supply Center at Norfolk, Va., according to the Bureau of Supplies and Accounts.

Under the terms of a contract awarded to Rapids-Standard Co. Inc., an automated materials handling system will be installed at the Norfolk Naval Center to mechanize the issue of selected bin-stored supply items from warehouse picking to packing points. The contract, for $506,065, follows an earlier award to provide a similar materials handling system for the Naval Supply Center at Bayonne, N. J.

Bin issue automation, through the use of handling equipment such as conveyors and diverters, has become practicable because of recent consolidation of bin stocks at major supply activities and expanded use of the so-called popularity storage concept in which high-demand fleet support items are given preference positioning in warehouses. The new system will permit substantial savings in handling costs and speed stock distribution.



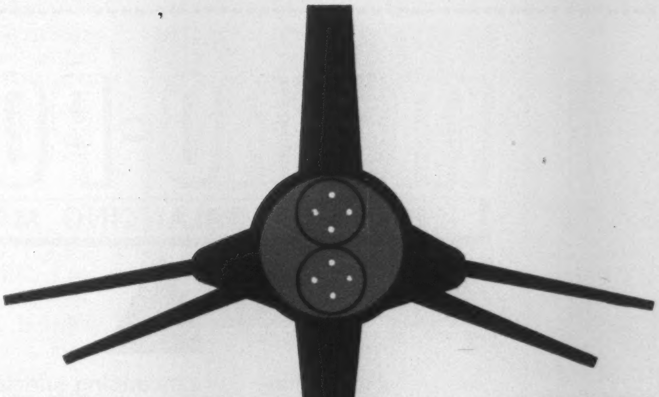
Bulk Liquid Packaged In Plastic Bags

DISPOSABLE - PACKAGE concept for handling liquids in bulk, previously applied successfully to the shipping and dispensing of sulphuric acid, has been introduced to the dairy industry by Scholle Container Corp. The concept involves filling of polyethylene bags with liquid on an automatic machine and placing the filled bags in waterproofed, corrugated boxes.

Principal advantages claimed for the process in milk handling include low packaging costs (approximately 6 cents per gallon) and a 40 per cent reduction in container space over that required for conventional metal milk cans. Other savings accrue from the elimination of metal can cleaning and sterilization equipment, and can maintenance. Since the package is disposable, the costs of returning empties and accounting for deposits are also avoided.

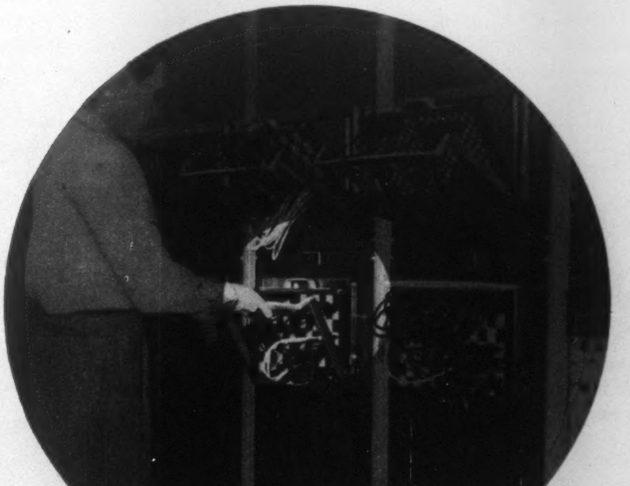
In filling with the new method, a sealed polyethylene bag is first placed flat on the weighing platform of an automatic machine developed

NONELECTRONIC numerical control system for machine tools has been developed by Moog Servocontrols Inc. Heart of the system is a pneumatic tape-reading device that actuates pneumatic selector valves. When the selector valves have been positioned, hydraulic pressure is applied to worktable actuators and the table moves to the proper position called for on the tape. Hydraulic pressure is then relieved and pneumatic pressure applies table clamping force. Pneumatic pressure also acts to select a tool, control the tool feed rate, and initiate coolant flow. Automatic retraction of the tool at the completion of a machining operation restarts the positioning cycle by advancing the tape to read the next block of information. In the illustrations, a Z-axis control system has been applied to a turret drill manufactured by Burg Tool Mfg. Co. At left, a punched tape containing machine cycling instructions is shown being loaded into the pneumatic tape reader. A blank part is then inserted in a fixture on the worktable of the turret drill, center. In right photo, hydraulic pistons at right center and rear background position worktable to the correct location for drilling. Repeatability of ±0.0003-inch and table positioning within ±0.0005-inch are possible.



Thiokol PROGRAMS X-15 ENGINE TESTS WITH AMP PATCHBOARDS

To test the 50,000 pounds of whoosh in its new X-15 engine, Reaction Motors Division of Thiokol Corporation required versatile and reliable programming systems to connect instrumentation to six different test stands. With the assistance of AMP engineers, Thiokol installed six patchboard programming systems that can connect one set of test instruments of any of six test stands with a flick of the wrist—a saving of time, personnel and equipment. In addition to tremendous flexibility, AMP systems—either universal or shielded—provide a number of exclusive features including pre-cleaning of contact pins and springs, rugged take-a-beating construction, an almost unlimited range of sizes, plus electrical characteristics suited to the most sensitive applications—all contributing to top notch reliability. **For the complete story, write for our Patchcord Programming Catalog.**



Reaction Motors' technician switches instrumentation from one test stand to another with a flick of the hand.

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- Fans
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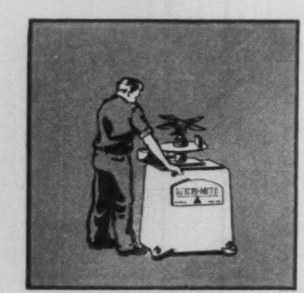
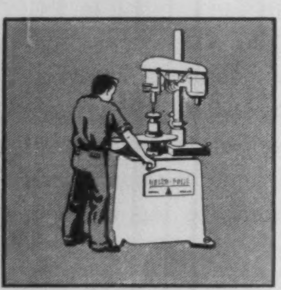
- Brake drums
- Pumps
- Jet engine components

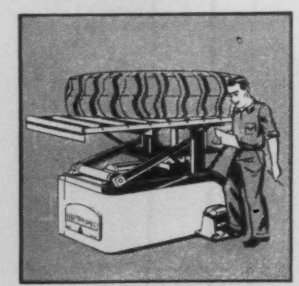
—and many other rotating parts



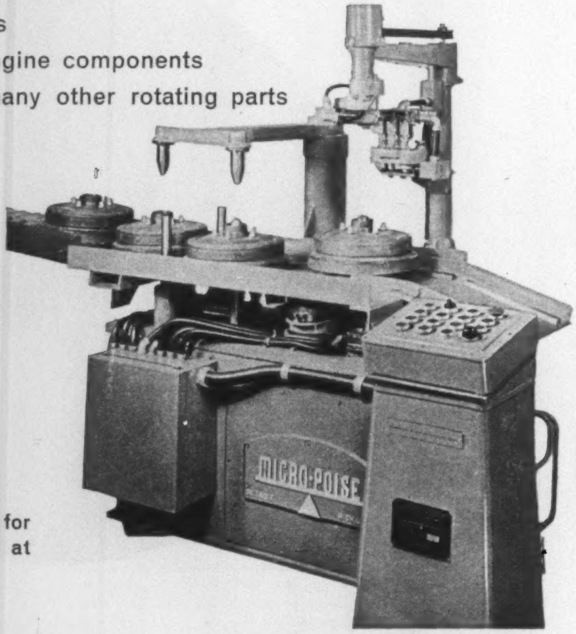
BASIC MICRO-POISE is equal to most rigid balance specifications.



Accessory drill presses or welding units allow correction on the machine.



Conveyorized or power loading models available for fast or heavy work-piece handling.



AUTOMATED MODELS for continuous production at highest production rates.

MICRO-POISE ENGINEERING & SALES CO.

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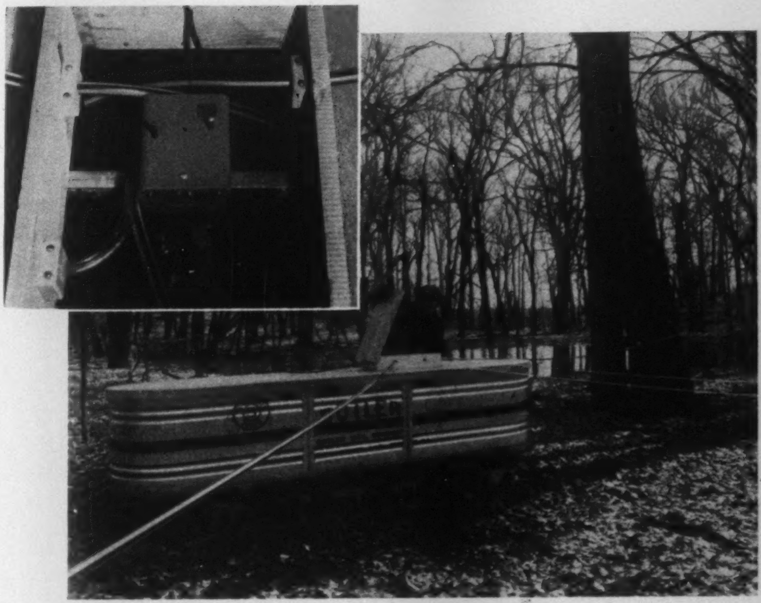
Circle 660 on Page 19

by the company. A filling tube on the machine then pierces a collar on the bag. Operation of a pushbutton starts the filling cycle, and milk is forced through the collar into the bag until a predetermined weight of milk has been added, and the machine stops. A cap with a sealed dispensing tube attached is then threaded on the collar, and the filled bag is slid off the weighing platform and into the corrugated box. When the box has been sealed, code-dated, and identified, the unit is ready to ship.

Dispensing of milk at the point of use is equally convenient. A perforated tab at the top of the box is lifted and the dispensing tube is pulled out; the package is then inverted and the dispensing tube is placed in an opening in a dispensing machine. Next, the sealed end of the dispensing tube is sheared off and the milk is withdrawn.



COLLECTION of sap from maple trees on his property has been made an automatic process by LeRoy Alwin, an engineer with Minneapolis-Honeywell Regulator Co. First step was to provide a system of plastic tubing whereby sap from 300 trees could flow by gravity into a collecting tank at the bottom of a natural slope. When the liquid reaches a predetermined level in the tank, a ball float activates a Honeywell relay (inset) and a pump is started automatically. The sap is then pumped to a 2-stage evaporator that yields 1 gallon of syrup for each 40 gallons of sap. Up to 100 gallons of processed syrup is obtained annually with the setup.

EDP System Will Automate Data Handling for Bank

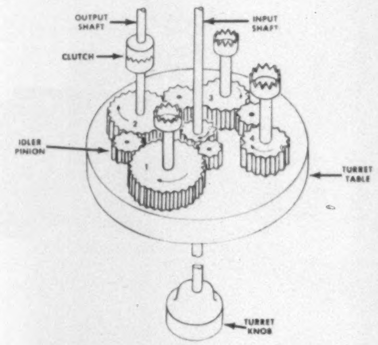
AN electronic data processing system to handle all of its record keeping and accounting functions has been ordered from International Business Machines Corp. by Mellon National Bank & Trust Co. in Pittsburgh.

The new system will include a transistorized IBM 7070 computer that can add or subtract 16,600 five-digit numbers a second. It will also have a number of input and output tape units, each of which can read or write information magnetically at rates up to 62,500 characters per second.

Supporting the 7070 will be several IBM 1401 computer systems and high-speed printers. In addition, reader-sorters will be included to handle check processing functions using magnetic ink character recognition techniques.

By reading magnetic ink numbers, the reader-sorters will make possible the direct input of data from checks and deposit tickets to the data processing system. With the information received from the reader-sorters, the computers will handle all check processing and checking account bookkeeping.

In commenting on the project, **John A. Mayer**, president of the bank, said: "The initiation of this program is an indication of Mellon Bank's intent to make the fullest possible use of technological advances, not only to maintain the service to which our customers have become accustomed but to expand and improve it."



STEP-FUNCTION speed reducer developed by Insco Co., Div., Barry Controls Inc., is easily adjusted to provide any one of several output speeds in relation to speed of input shaft. To change speed ratio, the turret table containing gears is retracted by pulling on a turret knob. This separates two clutch halves and interrupts the drive to the output shaft. When the turret knob is turned, a different speed ratio shaft (with a clutch half on its end) may be aligned with the clutch half on the output shaft. Pushing in on the turret knob will then engage the clutch halves and a new output shaft speed will result. Unit is suitable for recorder chart drives where several discrete gear ratios are desired. Other applications include use in programming timers, temperature-cycle controllers, scanners, and test devices. In light load, low torque applications the input shaft may remain rotating during a speed change cycle, and eight or more discrete gear ratios may be selected.

Pipe Casting Process To Be Franchised

PLANS to grant exclusive franchises in the U. S. for use of construction equipment to manufacture "instant concrete pipe" have been announced by Fullerform Continuous Pipe Corp., holder of patents on the "Inflataform" cast-in-place pipe process (See AUTOMATION, July 1960, p. 41).

The company's portable machinery casts pipe in place on the job and eliminates assembling sections

—angles

—tapers

—contours

LeBlond Tape-Turn

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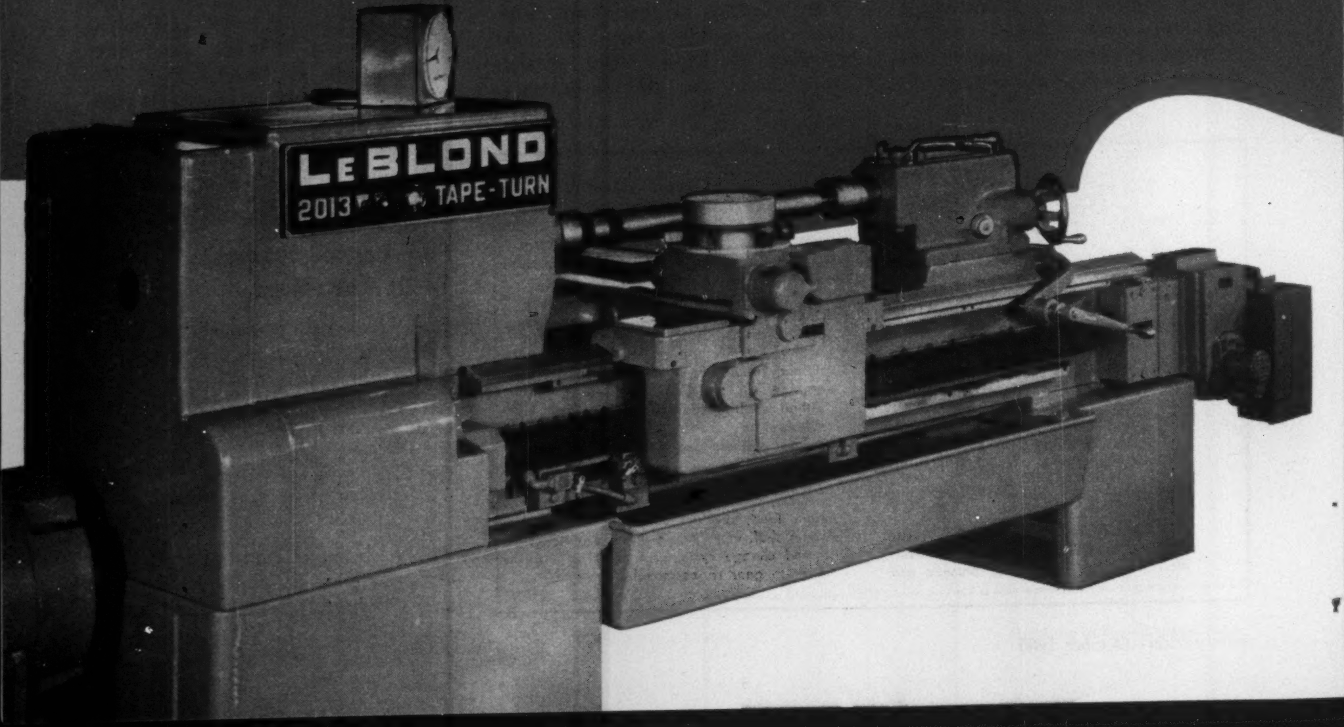
• solid state circuitry • no computer needed • no hydraulics and heat exchangers • no vacuum tubes • no templates


LeBLOND
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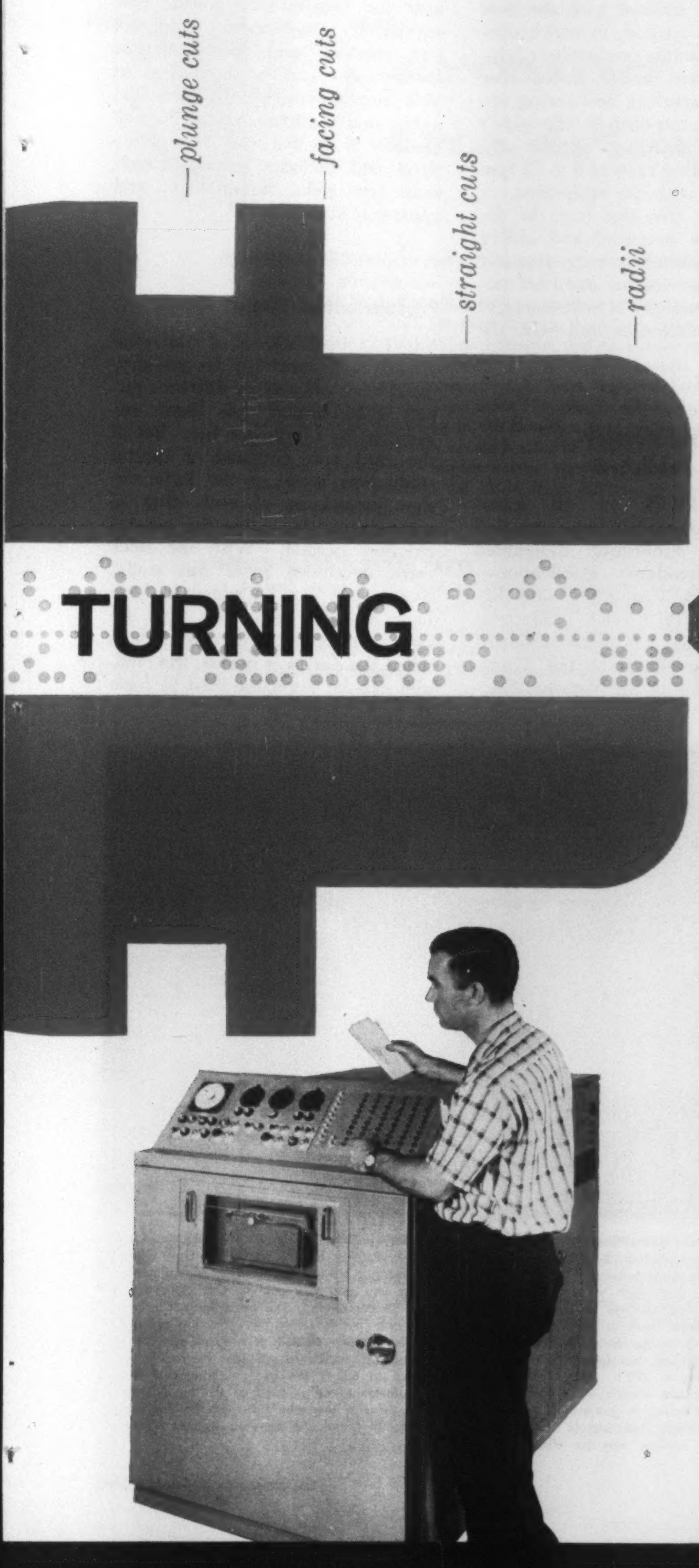

TURNING

Slopes, curves, straight cuts, angles, radii, tapers, facing cuts, boring cuts — you name it, this new LeBlond Tape-Turn Lathe can do it. And without steps, apologies, or a computer.

LeBlond Tape-Turn Lathes are all heavy-duty models with a special headstock and carriage engineered for General Electric's new Mark Century tape control. This potent combination can easily cut tracer turning time by half.

Here's all the stamina, power, and versatility you need for production work, coupled with the simplest contouring control yet developed. Uses 8-channel paper tape just like common positioning controls.

Requires only a sine-cosine table for programming slopes, and no special aids for straight cuts or curves. The console is equipped with a pushbutton keyboard for overriding the taped program.

Continuous path control — no steps. Screw cutting mechanism and control provision for curves with radii greater than 10″ available on special order.

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The R. K. LeBlond Machine Tool Co.

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Circle 661 on Page 19

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YODER
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If your slitting requirements call for coil widths from 12" to 60", in gauges from .015" to .250", the economy of purchasing Yoder Slitting Machinery can be yours. Operating a Yoder Slitting Line only one eight-hour shift per week, for example, could easily produce 35 tons of slit strands per week . . . or 1,820 tons every 52 weeks. At a slitting cost saving of only ½¢ per pound, the annual savings would amount to $18,200.

Additional savings can be realized through lowered inventory of mill-width coils – less waiting for delivery of special slit widths. Also, customer satisfaction will increase as you achieve faster completion and delivery of finished products.

At your request a Yoder sales engineer will study your plant operation to determine what equipment would most economically . . . and profitably . . . serve you, whether it be standard components or a completely specialized and engineered line.

Send for Yoder's illustrated text on slitting operations and equipment. It describes methods, time studies, operating cycles, material handling, and gives full specifications.

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ENGINEERING YODER MANUFACTURING
ROTARY SLITTING LINES

Circle 662 on Page 19

sections by hand-sealing their joints.

Cost savings from 15 to 30 per cent can be realized with the new construction method, in which concrete and portable production equipment are taken directly to job sites. Pipe manufacturing and curing operations are handled in the pipe's permanent mold — a freshly-cut ditch. Molding rates of 8 to 12 fpm are possible with the equipment.

Franchise area size is to be determined by potential and ability of the franchiseholder to properly cover and service his exclusive territory. Licensees will have the right to grant sublicenses and rent the machinery.

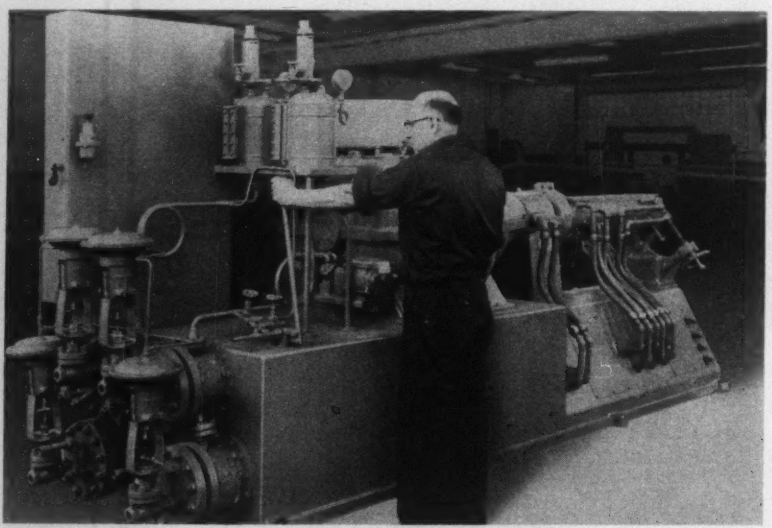
Data on Transformer Standards Published

INFORMATION on all transformer standards has been compiled in a new publication designated "NEMA Standards Publication—Transformers, Regulators, and Reactors; No. Tr 1-1960." Material for this book has been collected through the efforts of the Transformer Section of the National Electrical Manufacturers Association.

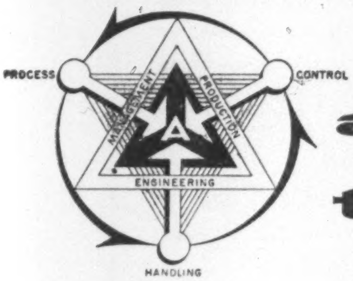
The text includes various standards for distribution, power, and regulating transformers, regulators and reactors, and special-purpose transformers such as those used in unit substations, electric arc furnaces, and industrial rectifiers. The material is divided into 20 separate parts and includes general standards, test code, terminology, and apparatus standards.

Prefabricated Circuit Cards

DEVELOPMENT of a universal circuit card that can be prefabricated and adapted to different circuit requirements has been announced by Librascope Inc. Before the card was designed, a careful study was made of the basic design parameters of each class of computer to determine the general circuitry needed. With the stock cards developed from this study, components can be added to form logic modules before the final design of a computer is ready. Then, when the design is firmed, the modules can be interconnected to form



LINE OF mixing machines, equipped with all necessary heating and cooling accessories for compounding plastics, has been developed by Baker Perkins Inc. designers working with American-Standard Industrial Div. engineers. Each mixing machine has two sets of two heat exchangers, with each set consisting of one heating unit and one cooling unit connected in series. Temperatures in three critical zones may be controlled. The basic heat transfer medium, which flows to the various sections of the machine, is water. For heating cycles, the water is pressurized to 200 psig. Steam, at pressures up to 250 psig, supplies initial heat to the heat transfer medium and is automatically controlled to maintain desired temperatures up to 370 F. For higher temperatures, up to 600 F, the heat exchanger shells can accomodate electric immersion heaters. In this instance, oil is used as the circulating medium. Cooling is performed with water passing through the tube sides of the cooling units. Automatic temperature controls interlock the heating and cooling units so that either heating or cooling may be effected as required.



around the triangle

CLADDING TECHNIQUE IMPROVES SEMICONDUCTOR MANUFACTURE

Aluminum preforms clad on both sides with indium are now available for use in forming "P" type alloy junctions in germanium semiconductor devices. The process for cladding aluminum with indium, developed by Accurate Specialties Co. Inc., involves a sequential melting technique that is said to provide a true metallurgical bond at the interfaces between the different materials. The ability to introduce aluminum into germanium crystals helps improve emitter efficiency. However, aluminum forms a tenacious oxide film on the alloys and makes it difficult to wet the germanium. According to the firm, the new process produces a tri-clad material consisting of indium clad on both sides of aluminum, with no oxide present at the interface. During the semiconductor alloying operation the indium covers the aluminum and prevents the oxide from forming, as well as acting as a carrier into the germanium.

WELDS PAINTED METAL PARTS

Coated metal welder built by Precision Welder & Flexopress Corp. is applicable on materials such as steel coated on one side with paint, acrylic lacquer, or wood veneer. The welder can attach brackets, hinges, braces, and other parts to the uncoated side of preformed, decorative steels. A magnetic force projection welding method is used to fasten the materials. The magnet drives a forging hammer down on the weld projection, upsetting it at the instant of maximum heat, thus forging the weld.

TESTING TECHNIQUE ELIMINATES CALCULATIONS

A production testing technique eliminating the need for time-consuming calculations from quantitative test data readout has been developed by Giannini Controls Corp. The new system uses a single instrument servo to provide both go/no-go indication and quantitative readout in the form of per cent deviation from established nominal values relating to each test performed on an item under test. The instrument servo is used only as an error indicator and can achieve accuracies which, for absolute value indication, would require complex equipment. The unit can be programmed, will cover a wide range of test parameters and accuracies without requiring physical adjustment of the test equipment.

INSTRUMENT RECORDS EQUIPMENT PERFORMANCE

An instrument, called Productograph, has been introduced for the data processing field by Farrington Mfg. Co. The machine is designed to automatically record the operational status of up to 200 machines. Through a telecommunication system, machine operating times, downtimes, and the causes for downtimes may be recorded on a special graph and on a tape recorder at a central control point. In addition, the number of items being manufactured, time units, and nominal and actual outputs may be tallied on electrical and linear counters.

FEWER AIR POCKETS IN ELECTRICAL CERAMICS

A pressure firing technique used in the manufacture of ferroelectric and piezoelectric ceramics for ultrasonic and electronic uses has reduced voids or air pockets by 80 per cent, according to Dr. Leslie K. Gulton, president and chairman of Gulton Industries Inc. The reduction of voids is said to contribute to high piezoelectric sensitivity, high dielectric constant, low dielectric and acoustic losses, and improved temperature stability. The technique also produces ceramics having uniform grain size with corresponding consistency of electromechanical properties. One-piece transducer discs as large as 20 inches in diameter can be made by the process.

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416	456	496	536	576	616	656	696	736	776	816
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425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
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COMPANY

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CITY ZONE

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401	441	481	521	561	601	641	681	721	761	801
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403	443	483	523	563	603	643	683	723	763	803
404	444	484	524	564	604	644	684	724	764	804
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406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
422	462	502	542	582	622	662	702	742	782	822
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424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	759	799	839
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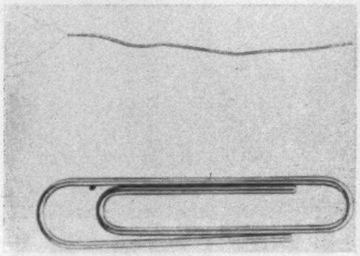


HIGH TEMPERATURE heating wire announced by Amperex Electronic Corp. is suitable for heating objects in a vacuum or under pressure, and maintaining elements such as sodium in a liquid state. The heating wire is available in diameters ranging from 1 to 2 mm and in lengths up to 280 ft. The wire can be heated to temperatures as high as 1100 C, with maximum permissible current reaching 32 amps. In use, the heating wire is coiled around an object to be heated and brought out through an oven. Using sealed bushings, the points where the wires are introduced into the heating system can be hermetically sealed.

---

the required circuits.

In producing universal printed circuit cards for various types of computers, assembly is divided into two steps. The first part is preassembly, at which point all cards destined for a specific class of computer look alike. The second phase of production involves working out the interconnections of individual modules to provide the proper circuits for a given computer. This is done after the computer design has been completed. Another innovation is that the etched circuits are carried through from the base plug of each card to the top of the card where a duplicate connector is provided. This permits the card to be connected to a test instrument while it is plugged into the computer.

Acquires Test Facilities For NC Machine Tools

NEW FACILITIES for assembling and testing numerically controlled machine tools have been acquired by Heald Machine Co., a subsidiary of Cincinnati Milling Machine Co., at its plant in Worcester, Mass.

In announcing the expansion, **Hartwell G. Howe**, vice president and general manager, said: "With our backlog for these machines the largest in history, the new and expanding field of numerically controlled machines makes necessary

WHO cut out WHAT word from the dictionary?

im-pos″si-bil′i-ty, *n.* [-TIES, *pl.*] **1.** The fact or state of being impossible. **2.** That which is impossible; something that can not exist or be done.—**im-pos′si-bly,** *adv.*

***THESE* are the men who cut it out:**

. . . part of the staff of Automation Engineering Laboratory, Incorporated . . . engineers, designers, inventors . . . yes, even dreamers. They have consistently solved "unsolvable" manufacturing, handling or processing problems . . . have designed and built "impossible" machines . . . that worked! They have done this for companies among the top five in such varied fields as Automotive, Electrical, Food, Paper, Textiles . . . etc.

Most important: in developing, designing and producing new or improved machines, processes and automated systems for industry, Automation Engineering Laboratory *has virtually eliminated costly risks of clients' capital!* How? By AEL's new concept of "**STEP-BY-STEP** Automation"®.

WHAT IS IT?

Briefly . . . it is AEL's systematic, step-by-step approach to creating equipment and processes. It involves *proving out* planned functions on working models . . . *one step at a time.* Function "A" is contracted for, completely proved out and demonstrated to you before Function "B" is even attempted . . . and so on. *Thus you will see your project operating in prototype within the first 15% of your total expenditure.* And, when your machine or system is completed, *it will work exactly as it should!* This is automation that any manufacturer can afford.

NOW...ABOUT YOUR PRESENT PROBLEMS

Whatever your automation problem, may we suggest you write or phone us? One of us will visit you . . . listen carefully to your problem . . . gather information. After studying your over-all layout, he will go back to Stamford and share your problem with other AEL Senior Staff Members. What he will then tell you is *"We can do it!"* and . . . on a contract basis you will appreciate. Remember, the word "impossibility" has been cut out of our dictionary. Try us.

AUTOMATION ENGINEERING LABORATORY
INCORPORATED

● **AEL Development and Research Division, Inc.**
AEL Manufacturing Division, Inc.
AEL Food Machinery Division, Inc.

84 Commerce Road • Stamford, Connecticut

RELIANCE

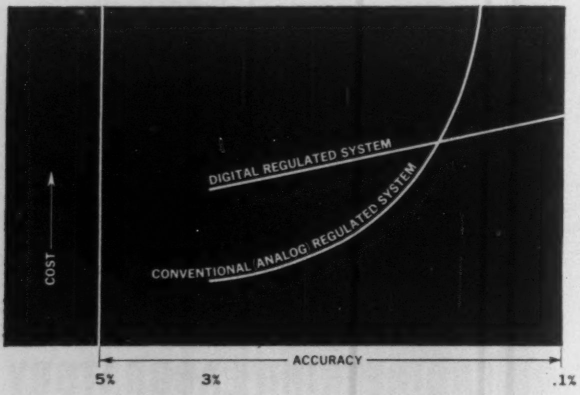
DIGITAL REGULATED

...accurate...economical...and

When accuracy requirements are greater than 1/10 of 1%, and where drift can cause a problem, these Reliance digital systems offer you an excellent answer.

Commands can be programmed easily and quickly into digital regulated systems. Systems can be built with memories and can perform complex calculations . . . from cards, tapes or dials.

Reliance builds these systems custom tailored to the job . . . from complete process control like automatic warehousing, assembly conveyor lines and tandem mills, to small special purpose systems such as press feeders, pipe cut-offs and board cut-to-length. These systems can be simple enough to give you the benefit of digital techniques without excessive cost or complexity.



DIGITAL SYSTEMS OFFER ECONOMIC ADVANTAGES

No-Drift Accuracy

Where analog-regulated systems rely on magnitude and polarity of feed-back signals compared with a reference, variations in reference will cause drift. Digital systems, however, receive "discrete pulses"; magnitude of pulse is not important.

Limitation on accuracy is usually mechanical; the electrical system is capable of .001% or better. Because of "discreet pulses", drift is eliminated. There is no cumulative error.

Full System Responsibility

Reliance gives you more than just digital regulation. You get an integrated, comprehensive, engineered system, including motors, variable speed (V★S) drive, digital regulator and the command control.

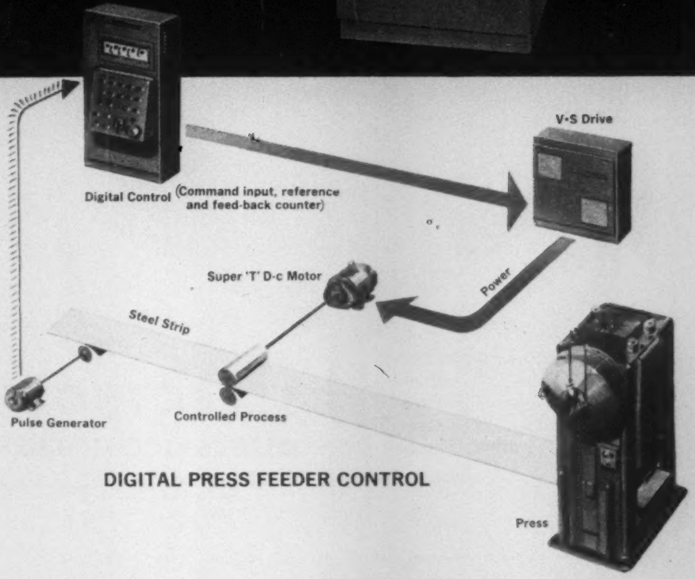
Special Purpose Systems

Starting with standard industrial components, Reliance designs a complete system — for rugged, maintenance-free, in-plant operation. Controls, in standard enclosures, are available for installation at the machine site.

Digital Press Feeder Control

This system is a prime example of precise control. Pre-set sheet lengths are programmed into the digital regulator with selector switches. The system permits the press to operate at maximum speed while compensating for sheet length and speed. Reliance V★S Drives supply the motive power . . . for increased production efficiency.

DRIVE SYSTEMS
built for the job


V·S Drive
Digital Control (Command input, reference and feed-back counter)
Super 'T' D-c Motor
Power
Steel Strip
Pulse Generator
Controlled Process
Press

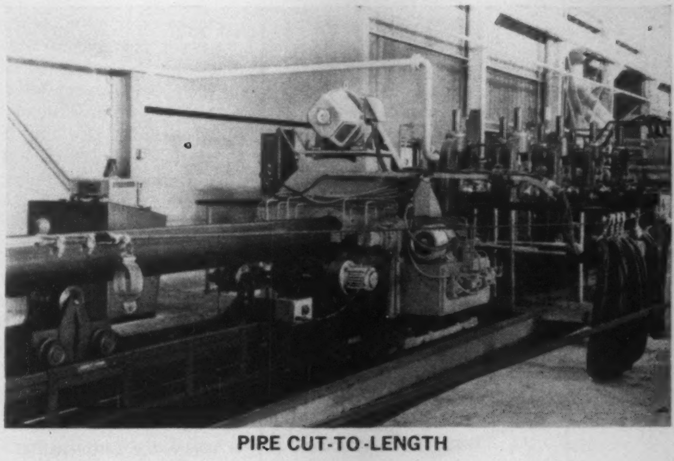
DIGITAL PRESS FEEDER CONTROL

Pipe Cut-to-Length

On this pipe fabricating line, the most demanding performance is required by the cut-to-length section. Pipe must be accurately measured and rapidly cut, without stopping the line. A digital regulator measures the pipe to 1/10 of an inch as it goes through the cut-off section. When the selected length is reached, the cut-off V★S Drive rapidly accelerates the carriage to line speed. The pipe is then clamped and cut. The carriage immediately reverses, measuring pipe length as it returns to its starting position. The cut-off carriage weighs 8 tons and is automatically accelerated to line speed in just *four inches of movement.*

Systems Engineering Assistance

Reliance Sales Engineers across the country can give you valuable assistance in systems engineering . . . follow the job through start-up, and render any additional service necessary. Call your nearest Reliance office, or write us direct for further information.



PIRE CUT-TO-LENGTH

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

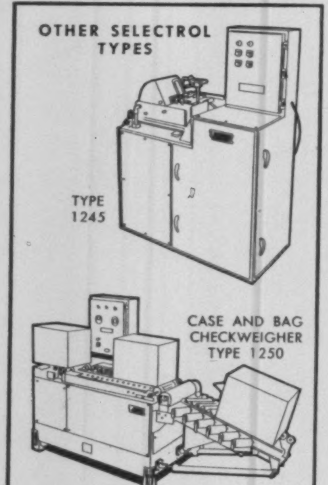
RELIANCE ELECTRIC AND ENGINEERING CO.
DEPT. 2610A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

L-1679

New Automatic Checkweigher

Signal lights and counters for control and adjustment of filling or processing machines are available as optional equipment.

SELECTROL®
offers accuracies of 2/10 of one percent


OTHER SELECTROL TYPES
TYPE 1245
CASE AND BAG CHECKWEIGHER TYPE 1250

This new Selectrol Checkweigher, Type 1206, sorts either closed or open packages and permits trimming of rejects. Operating speeds up to 120 weighings per minute; accuracies of 2/10 of one percent of the product weight. Greater speeds are possible at lower accuracies . . . and greater accuracies at lower speeds. Operation is completely automatic. Tolerances are adjustable.

Selectrols are made by Exact Weight, a manufacturer of scales for 45 years, with experience gained through hundreds of checkweighting installations during the past 18 years in 28 states and in foreign countries.

Write for Bulletin 3377.

Exact Weight SCALES

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BETTER QUALITY CONTROL . . . BETTER COST CONTROL

Circle 665 on Page 19

additional floor space for building and testing these complicated units. Numerical control is employed on Heald Bore-Matics, precision grinders, and new products under development."

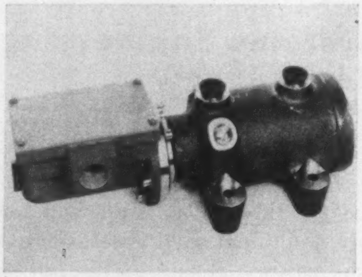
A special enclosed area, with air conditioning and humidity control, has been built inside the plant for assembling and testing the machines. Removable walls in the structure facilitate transfer of machines into and out of the area.

A constant temperature of 70F is maintained in the new area. Temperature and humidity control are necessary during assembly and testing of the numerically controlled machines in order to ensure maximum precision and repetitive accuracy of the units. The same conditions are required for best results during operation in users' plants.

Ridges On Conveyor Belt Improve Lift Characteristics

CONVEYOR BELT with diagonal ridges on its top has been developed by Hewitt-Robins Inc. to carry wet sand, gravel, dry grain, and other materials up steep slopes.

The new belt, called a "Cleat Top Belt," can rise as much as 21 degrees without the slip-back encountered with smooth-cover belts. When the belt is operated on an incline with the open ends of its diagonal ridges aimed in the direction of belt travel, moisture in the load is re-



DIFFERENTIAL pressure transmitter is sensitive enough to detect small pressure differences measured between points in a system operating at pressures as high as 2500 psi. The electrical output of the unit, introduced by Consolidated Controls Corp., varies from 0 to 1 v dc over the entire pressure differential range and can be used to activate various indication and control devices. Standard differential pressure ranges available are 0 to 90 inches of water; 0 to 140 inches of water; 0 to 200 inches of water; 0 to 400 inches of water; 0 to 10 psi; and 0 to 220 psi.

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Nº 1625
E. W. BLISS CO.
HASTINGS MICH.
U.S.A.

1000 strokes a minute!

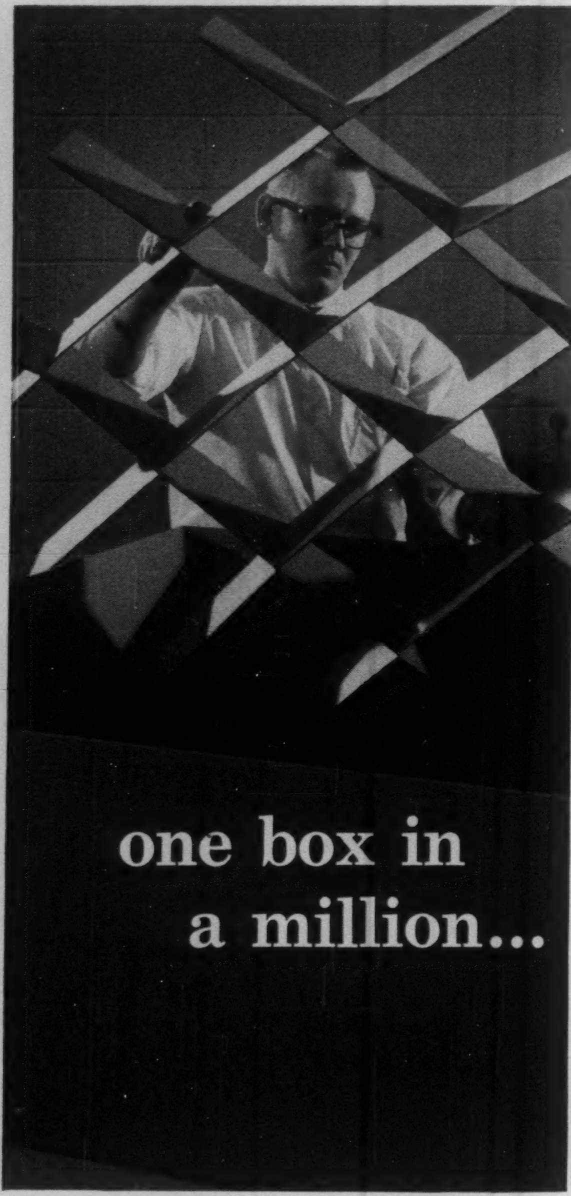
Now in daily operation at the Truarc Retaining Rings Division of Waldes-Kohinoor, Inc., of Long Island City, New York, this new Bliss High Production Press is running at the blurring speed of 1000 strokes a minute, hour after hour, day after day. First of its kind, this completely new press has a revolutionary counterbalancing system and massive, close tolerance construction that virtually eliminate vibration, even at this phenomenal speed. Could a press like this cut your parts cost... add to your profit picture? We'll be glad to give you the facts.

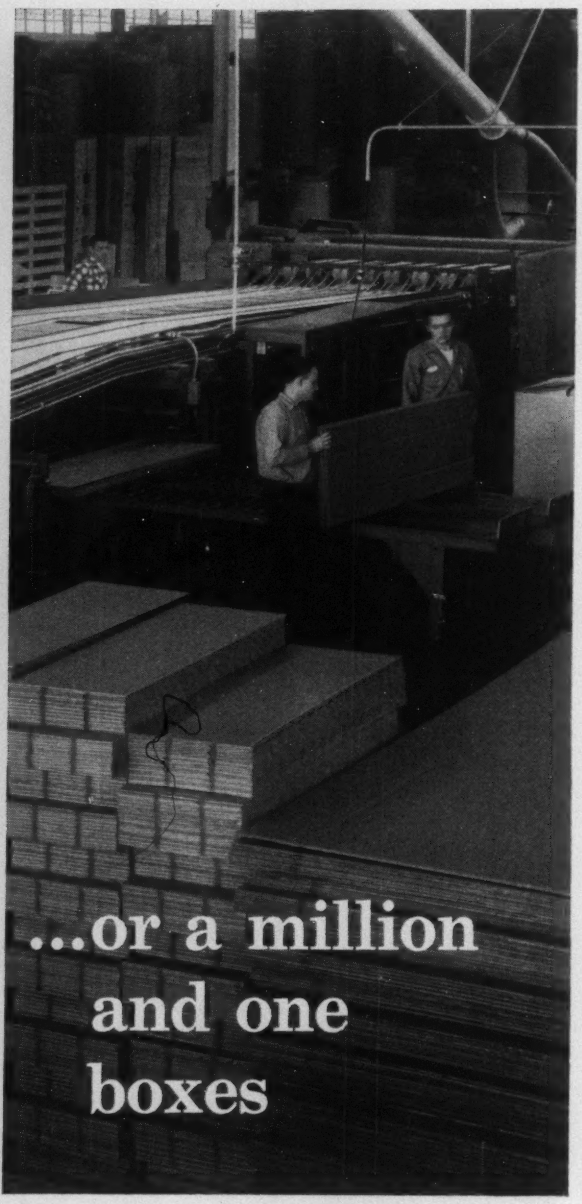
BLISS
SINCE 1857 ®

E. W. BLISS COMPANY · Canton, Ohio

BLISS is more than a name—it's a guarantee

Circle 666 on Page 19



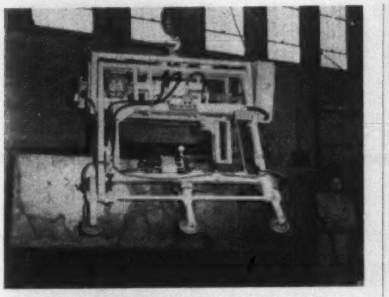


Perhaps you need a completely new type of corrugated package, for a product that requires ingenious container design. If so, you'll benefit from Hinde & Dauch's *creative approach* to package engineering. Or maybe you use standard shipping boxes in great quantity. In that case, you can count on H & D's large volume capacity—more than six billion square feet per year—to keep you supplied for uninterrupted production.

Hinde & Dauch Division
West Virginia
Pulp and Paper

HINDE & DAUCH DIVISION, WEST VIRGINIA PULP AND PAPER, SANDUSKY, OHIO • 17 PLANTS • 42 SALES OFFICES

Circle 667 on Page 19



VACUUM turnover unit, designed by Vac-U-Lift Co., Div., Siegler Corp., can lift and position stainless steel sheets for a line of six polishing machines. Unit consists of two pad beams, each with six pads. It will lift a stainless steel sheet from a stock stack, place it on a polisher, lift it after polishing, tilt it 90 degrees for inspection, return it to a horizontal position, and stack it without marring or scratching. If both sides of the sheet are to be polished, a complete 180 degree turnover can be accomplished by transferring the sheet to the second 6-pad beam, positioning the sheet for polishing the other side, and moving it from the polisher to a stack.

tained uniformly throughout the length of the belt. If the belt is run with the open ends of the diagonal ridges trailing the direction of travel, water is drained off the material being transported. This is desirable when handling sand, gravel, and ore.

The belt is available in widths ranging from 12 to 30 inches; wider sizes will be produced in the future. Experience indicates that various materials can be handled on the belt at the following approximate angles: Wet sand and gravel, 21 degrees; heavy-consistency wet concrete, 21 degrees; "soupy" concrete mix, 15 degrees; and dry grain, 20 degrees.

Remington Rand To Lease Business Office Equipment

LONG-TERM lease plan involving typewriter, adding-calculating machine, and systems products has been announced jointly by **Kenneth R. Herman**, president of Remington Rand Div., Sperry Rand Corp., and **Robert Sheridan**, president of Nationwide Leasing Co. The leasing firm will underwrite the Remington Rand lease program throughout the country.

Leases can range in size from as little as $175 for a single adding machine up to hundreds of thou-

solve your control problems with **SENECA FALLS control systems and components**

Complete systems available from fractional to integral horsepower for control of:

speed . . . position . . . instruments . . . manufacturing processes . . . single and two dimensional tracers . . . synchronized drives, etc.

In addition to complete systems we can supply:

sensing devices . . . control components . . . tape controls . . . power drives . . . any tables, carriages or other movable structures required.

Seneca Falls Systems are equally suitable for the conversion of existing equipment and the control of new equipment.

INVESTIGATE the unique Seneca Falls MECHANICAL POWER AMPLIFIER. It's a simple, power servo drive in striking contrast to the more complex electrical and hydraulic devices. Years of service in rugged applications prove its dependability, long life and negligible maintenance. Its excellent dynamic response permits the design of high sensitivity control systems.

SENECA FALLS MACHINE

PIONEERS IN AUTOMATION

8

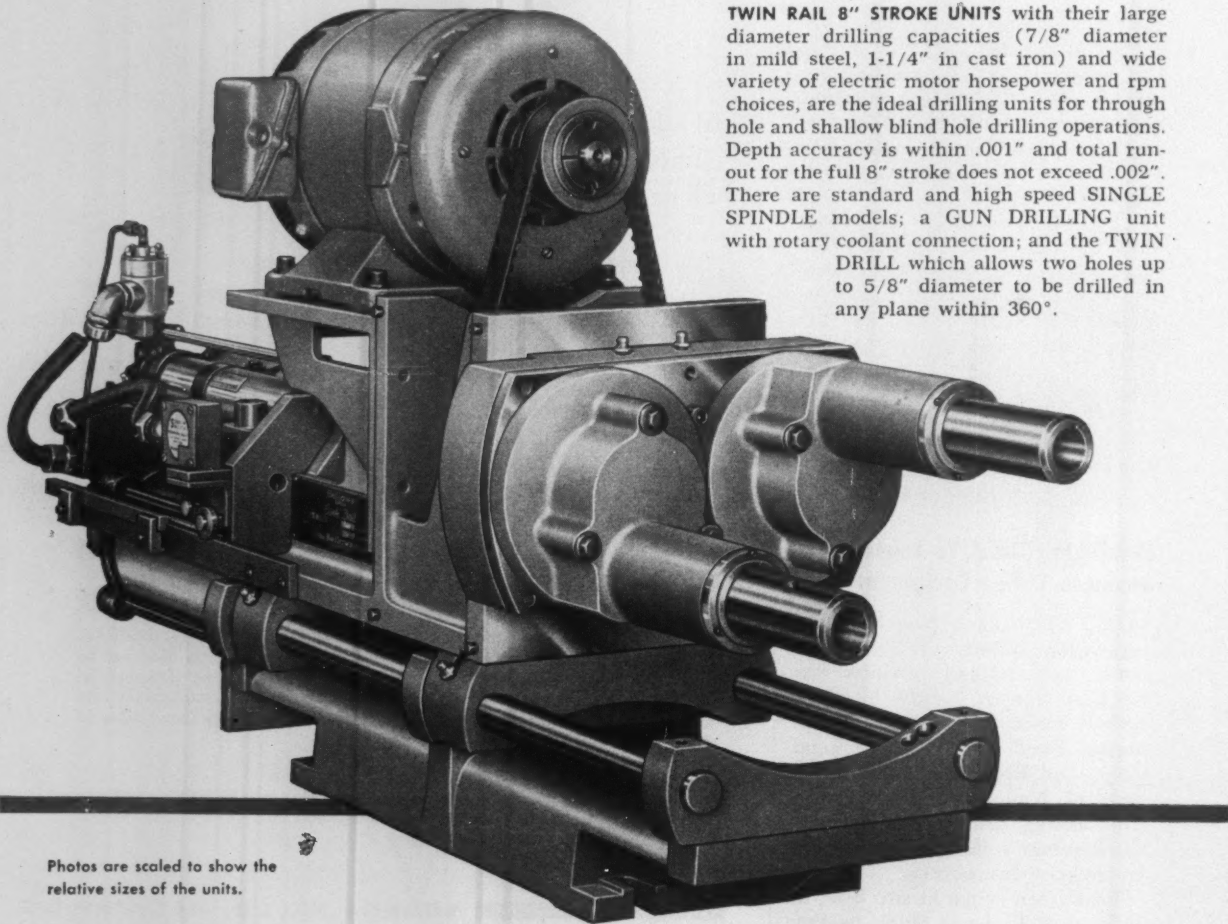
Write Dept. A for Bulletin EE1008 and, if possible, tell us all you can about your control problem.

SENECA FALLS, MACHINE CO.
ELECTRONICS DIV. • SENECA FALLS, N. Y.

Circle 668 on Page 19

FOUR SOLUTIONS TO LOWER

These four basic Bellows-Valvair Drill Units, all air-powered, hydraulically controlled, electrically actuated, can make nearly any drilling operation more productive, less costly



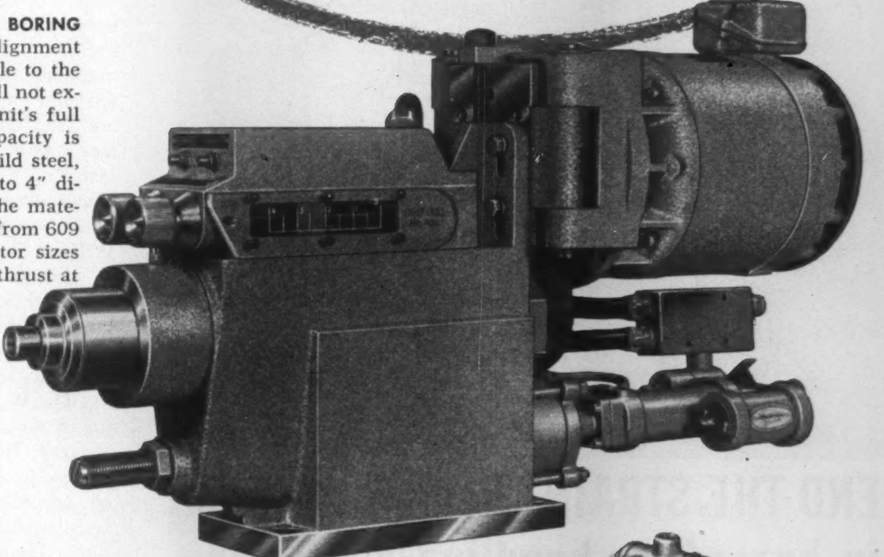
TWIN RAIL 8" STROKE UNITS with their large diameter drilling capacities (7/8" diameter in mild steel, 1-1/4" in cast iron) and wide variety of electric motor horsepower and rpm choices, are the ideal drilling units for through hole and shallow blind hole drilling operations. Depth accuracy is within .001" and total runout for the full 8" stroke does not exceed .002". There are standard and high speed SINGLE SPINDLE models; a GUN DRILLING unit with rotary coolant connection; and the TWIN DRILL which allows two holes up to 5/8" diameter to be drilled in any plane within 360°.

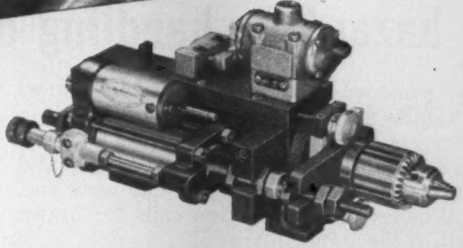
Photos are scaled to show the relative sizes of the units.

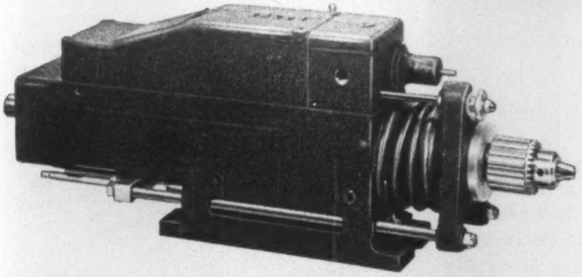
COSTS IN

DRILLING • TAPPING
BORING • REAMING
SPOT-FACING
COUNTER-BORING

"CARBI-DRILL" PRECISION BORING UNIT has so perfect an alignment that total runout of spindle to the machined base surface will not exceed .001" T.I.R. in the unit's full 4" stroke. Its drilling capacity is up to 5/8" diameter in mild steel, boring capacity is 1-1/2" to 4" diameter, dependent upon the material. Spindle speeds range from 609 to 6275 rpm (electric motor sizes from 3/4 to 2 hp). Power thrust at the quill is equal to 10 times applied air line pressure.







BELLOWS-LOCKE DRILLING and TAPPING UNITS are high speed drilling machines with a 3" stroke, drill capacity ranges from a No. 80 to 5/16" diameter. Rate of feed and speed of advance and retract are fully controllable. Units are available for pulley drive (as in photo), motor mounted parallel, and motor mounted "inline."

MODEL 22A DRILL HEAD has special advantages in close-quarter applications. The Hydro-Check (optional) provides a precision feed rate for the 2" stroke. Drill capacity is 3/16" diameter in mild steel. It can be mounted singly or in groups for synchronous operation . . . a versatile unit for drilling operations in wood, plastics, rubber, and light-gauge metals.

871C

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

Bellows-Valvair, Division of IBEC, Akron 9, Ohio

Please send me full details on Bellows-Valvair Drill Units

AU-1060

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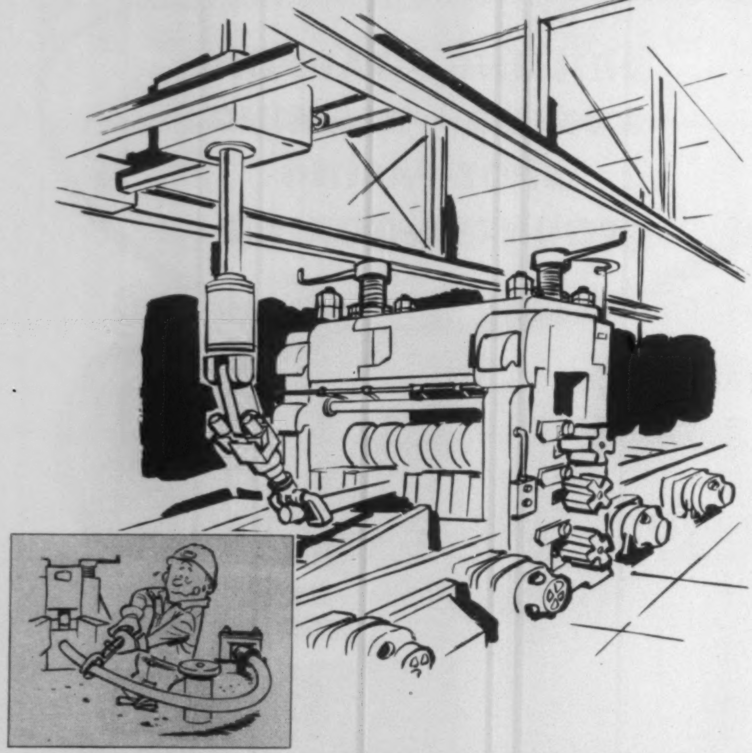
New twists in programmed manipulation from General Mills



END THE STRAIN! Remove the risk in hazardous handling operations

Here's one way a General Mills Mechanical Arm could be used to handle glowing hot, springy stock in a rod drawing mill. There are hundreds of other areas where the Mechanical Arm can free workers of drudgery, danger and boredom inherent in many industrial tasks . . . *and* save you money!

Whenever the situation calls for brawn and careful placement, a Mechanical Arm fills the bill . . . combining Herculean strength and a watchmaker's deftness. Coupled with a General Mills analog controller, the Mechanical Arm can perform a complex series of wrist-arm motions . . . endlessly, tirelessly and without human error!

Flexibility of the General Mills controller permits low-cost change of instructions for inline production at other stations . . . or even switch to manual remote control. Initial instructions are recorded on a plastic chart by manual operation of the master console. Thereafter, electronic playback duplicates complex wrist actions.

For more facts about programmed manipulation, write for *Automatic Handling: General Mills, Nuclear Equipment Dept., 419 North Fifth Street, Minneapolis 1, Minnesota.*

Nuclear Equipment Department

General Mills

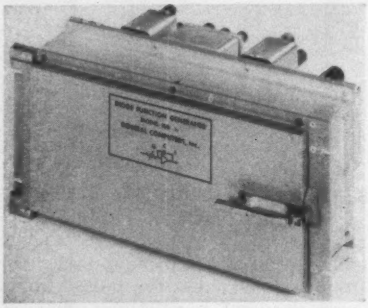
MECHANICAL ARMS

First in Remote Handling

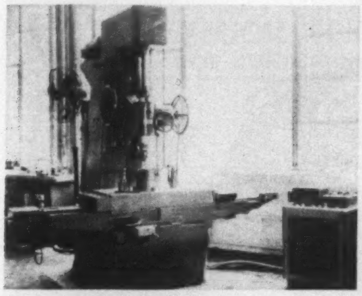
sands of dollars for complete office systems. Normally, lease periods will range from 39 to 65 months with renewal options upon expiration.

SPOTLIGHTING PEOPLE

Thomas A. Guerin named manager for electrochemical, hygrometer, amplifier, and leak detector product lines, Scientific and Process Instruments Div., Beckman Instruments Inc. . . . **W. W. Smith** appointed manager of the California Plant, Distribution Assemblies Dept. General Electric Co. . . . **James M. Wallace** named manager of the Manufacturing and Repair Div.; **Ray H. Timmons** appointed manager of the central region, M & R Div.; and **William T. Pitzer** named assistant to the division manager, all at Westinghouse Electric Corp. . . . **James H. McGarry** appointed director of manufacturing for the Mechanical Div., General Mills Inc. . . . **Dr. W. Wai Chao** named director of research and development at Vickers Inc., Div., Sperry Rand Corp. . . . **Frank P. Houpt** appointed administrative director for the Industrial Instruments and Systems Div., Fischer & Porter Co. . . . **Lewis H. Kinsley** named chief engineer of the Arthur Colton Co. . . . **W. Blake Tripp** appointed plant



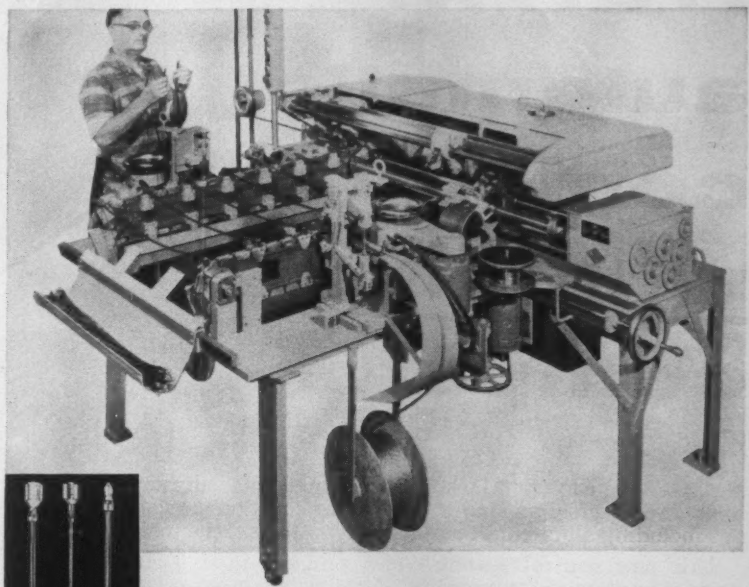
NONLINEAR functions can be programmed rapidly with a diode function generator developed by General Computers Inc. Internal programming of the device occurs when a door is closed over a punched card. Spring-loaded plungers in the door pass through the holes in the card and actuate sealed switches. These switches set up resistance networks for the desired function. Output of the unit is a programmed function of the input voltage and may be represented graphically by 20 contiguous line segments. The zero offset and slope at each breakpoint are programmed by the punched card.

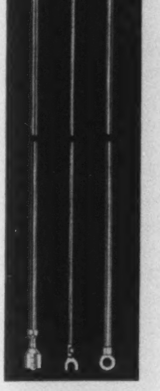


ACCURACY of up to 0.0002 inch on a 40-inch work table is a feature of numerical control system developed by Diehl Mfg. Co., subsidiary of Singer Mfg. Co. The numerical positioning control system comprises two basic functional sections—data processing and response mechanism. The data processing section establishes an analog signal proportional to machine motion from a fixed reference point. The response mechanism section establishes machine motion proportional to the analog signal output of the data processing system. Final positioning is obtained by means of a special electromechanical micrometer system.

manager of United Welders Inc. . . . **Dr. Jack S. Anderson** named director of engineering for a newly-formed Systems and Controls Group at Crane Co. . . . **Victor T. Goldfarb** appointed manager of programming of Teleregister Corp. . . . **Robert E. Wesslund** joined the engineering staff of Control Data Corp. . . . **Roy D. Wilson** appointed general manager of F. J. Stokes Co. of Canada, Ltd. . . . **John H. Zauner** joined the Instrument Div. of Perkin-Elmer Corp. as director of engineering. . . . **T. Maurice Butler, George B. Holmes,** and **Brian W. Pollard** named assistants to the vice president of manufacturing and engineering at Burroughs Corp. . . . **Robert L. McMasters Jr.** appointed supervisor, distributor promotion, and **Donald E. King** named supervisory engineer, special control engineering group, both in the Control Dept. of Allis-Chalmers Mfg. Co. . . . **Fred B. O'Mara** named vice president—production at National Carbon Co., Div., Union Carbide Corp. . . . **Jerome L. Strauss** appointed vice president and general manager of Budd Electronics Inc., subsidiary of Budd Co. . . . **Salvatore J. Intagliata** joined Systematics, Div., General Transistor Corp., as director of engineering. . . . **George Maynard** appointed chief production engineer of Gertsch Products Inc. . . . **Frederick B. Hull** joined

Produce 4,000 finished wire leads per hour...with terminals at both ends!





NEW ARTOS CS-9-AT AUTOMATIC MACHINE

1. measures any type of wire.
2. cuts off wire to length.
3. strips one or both ends.
4. attaches terminals at both ends.
5. provides stations for other work.

NOW YOU CAN produce up to 4,000 finished wire leads per hour—*with terminals attached at both ends*—when you install this new high-speed machine.

The ARTOS CS-9-AT handles almost any type of wire automatically. Taking wire from the reel, it measures, cuts to length, strips insulation, attaches terminals and provides uniform collection of the finished leads. Most types of terminals in prefabricated strip form can be used.

Also, the machine is furnished with a multi-station conveyor that permits several stations to be used for secondary operations such as inspection, twisting, welding, etc.

Get the complete story on the new ARTOS CS-9-AT—ask for engineering advice on your special problems.

ARTOS CS-9-AT CAPACITY
Wire Sizes: 20-gauge to 4-gauge.
Cutting Lengths: 6″ min. to 90″ max.
Stripping Lengths: 3/16″ to 1½″.
Output: 6″-45″ lengths—4,000 per hr.
45″-90″ lengths—2,000 per hr.

Write for Free Bulletins

Bulletin 358 describes CS-9-AT machine. Also ask about other Artos machines to handle wire from 30 to 000 gauge; cut lengths from 2 in. to 45 ft.; strip insulation from 3/16 in. to 10½ in.

AGENTS
THROUGHOUT
THE WORLD

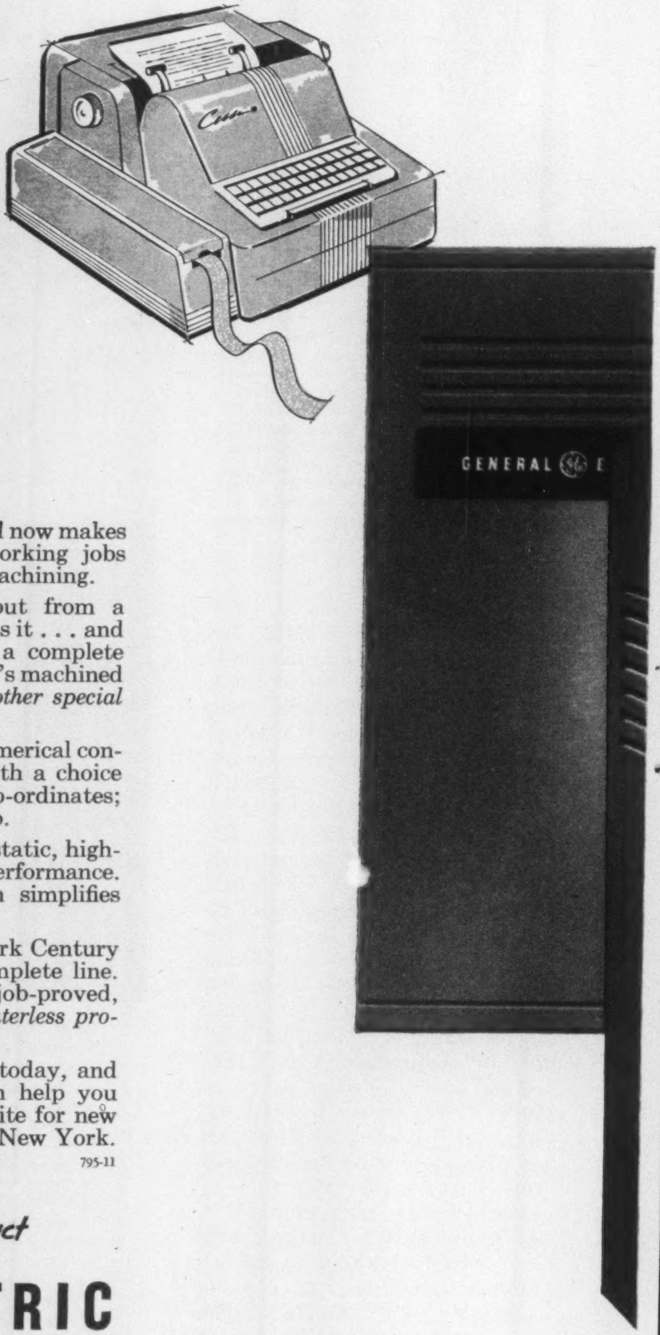
World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.
2785 South 28th Street • Milwaukee 46, Wisconsin

Circle 671 on Page 19

NOW...

automatic contouring without a computer



New General Electric Mark Century numerical control now makes *computerless programming* a reality for most metalworking jobs . . . including all circular, angular, and straight-line machining.

This new control system takes punched-tape input from a standard automatic typewriter . . . reads and interprets it . . . and automatically commands the machine to carry out a complete machining cycle. Producing more than 85% of industry's machined parts can be as simple as that—*with no computer or other special equipment necessary!*

Contouring or absolute positioning—Mark Century numerical control comes in a compact, "building-block" package with a choice of: 1-, 2-, 3-, 4-, or 5-motion positioning to absolute co-ordinates; 2- or 3-motion contouring; or a combination of the two.

Solid-state devices, modular construction—Completely static, high-speed logic circuits mean long life and dependable performance. New General Electric plug-in, modular construction simplifies maintenance and inspection.

Another member of the G-E program control family—Mark Century control is the newest addition to General Electric's complete line. It supplements the industry-renowned Mark series of job-proved, low-cost numerical positioning control to bring *computerless programming* to America's metalworking industry.

See your machinery builder or G-E Sales Engineer today, and find out how General Electric numerical control can help you increase productivity and cut machining costs. Or, write for new bulletin to General Electric Company, Schenectady 5, New York. Specialty Control Dept., Waynesboro, Va. 795-11

Progress Is Our Most Important Product

GENERAL ELECTRIC

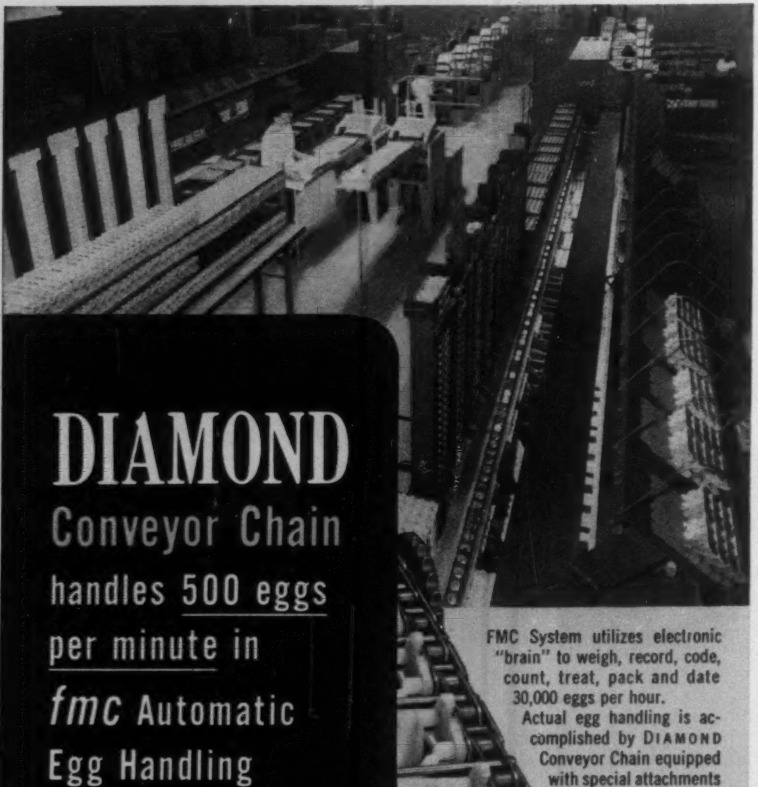
NEW MARK CENTURY

NUMERICAL CONTROL
FOR AUTOMATION

GENERAL ELECTRIC

NUMERICAL CONTROL

Circle 672 on Page 19



DIAMOND
Conveyor Chain
handles 500 eggs
per minute in
fmc Automatic
Egg Handling
System

FMC System utilizes electronic "brain" to weigh, record, code, count, treat, pack and date 30,000 eggs per hour. Actual egg handling is accomplished by DIAMOND Conveyor Chain equipped with special attachments and nylon egg cups.

◆ With split-second precision, DIAMOND Conveyor Chain receives, moves, positions *240,000 eggs during each eight hour shift.* It's a high-speed operation where a momentary foul-up could cause a king-sized omelette; where synchronization, timing and dependable, *trouble-free service* are absolutely essential. That's why Food Machinery and Chemical Corporation specifies DIAMOND Conveyor Chain for its electronically controlled Automatic Egg Handling System.

DIAMOND CHAIN COMPANY, INC.
A Subsidiary of American Steel Foundries
Dept. 412, 402 Kentucky Avenue • Indianapolis 7, Indiana

DIAMOND ROLLER CHAINS ®

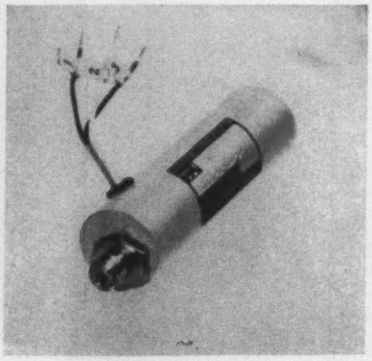
Offices and Distributors in all Principal Cities

Circle 673 on Page 19

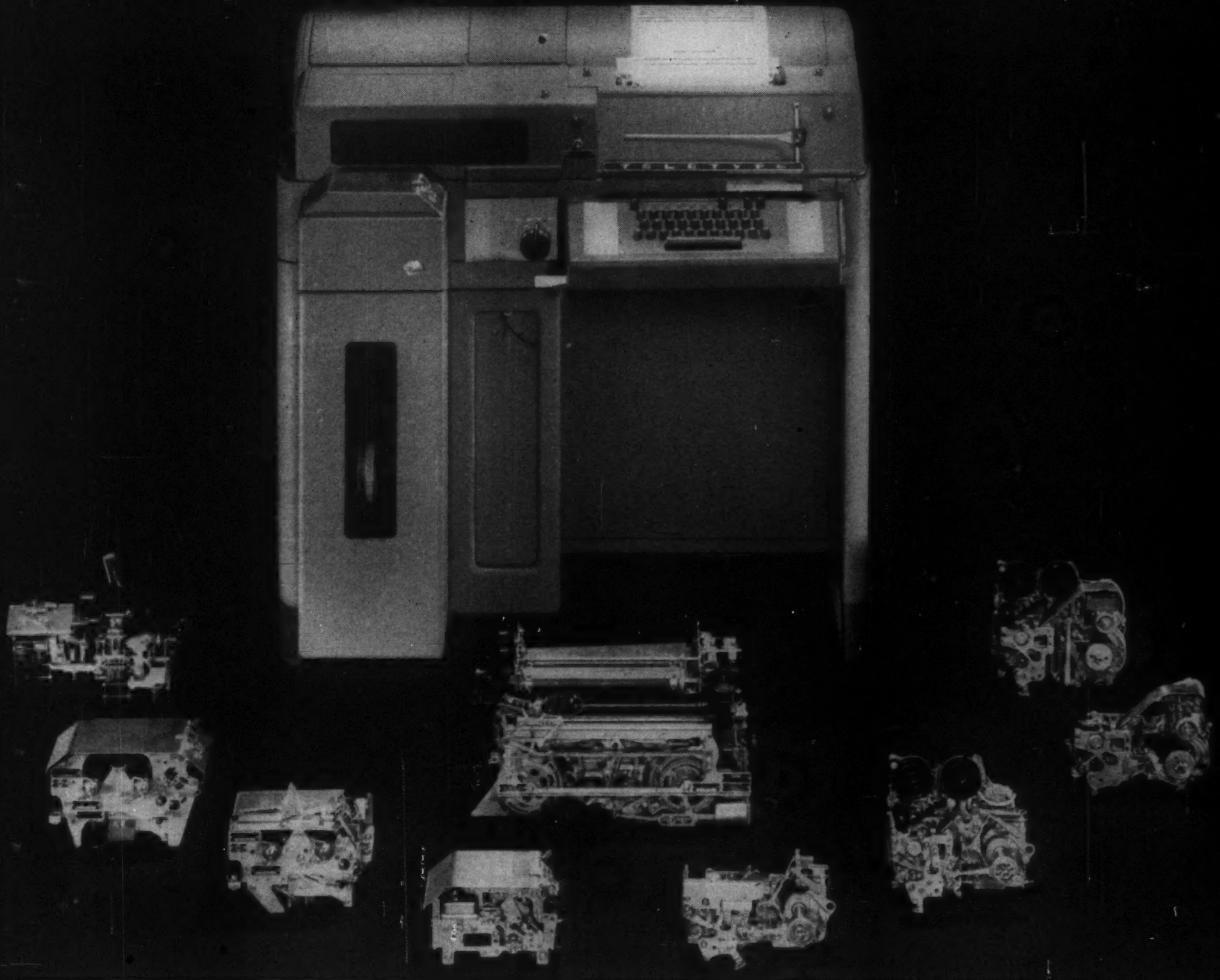
the Process Equipment Div., Bethlehem Foundry and Machine Co., in the position of process engineer. . . . **Albert Ross** elected executive vice president and **Harold S. Prigozen** elected vice president in charge of manufacturing, both at Standard Electrical Products Co.

SPOTLIGHTING PLANTS

Hoover Ball and Bearing Co. has consolidated all ball manufacturing, engineering, sales, and administrative functions of the Hoover Ball Div. Headquarters of the division will be at Middletown, Ohio. Manufacturing facilities at Hoover's Ann Arbor, Mich., plant will be integrated into the firm's plants at Middletown and Erwin, Tenn. . . . **Taylor Fibre Co.,** manufacturer of laminated plastics and vulcanized fiber, has acquired the business and assets of Dytronics Inc., manufacturer of die-stamped circuits for electrical and electronic applications. Taylor Fibre will operate Dytronics as a subsidiary at its present location in Rochester, Mich. . . . **Vickers Inc., Div., Sperry Rand Corp.,** has established a new manufacturing facility for hydraulic cylinders in Waterbury, Conn. The new plant includes complete engineering, manufacturing, processing, raw stores, and warehousing facilities. . . . **Crane Co.** has recently formed a



MINIATURE pressure transducers capable of measuring up to 15,000 psi, and weighing less than 0.25 lb, have been developed by Colvin Laboratories Inc. The transducers measure 1-inch in diameter and are available in various resistance values. The units can measure gage, absolute, or differential pressures. For special applications, they can be made to withstand temperatures up to 600 F, vibration as high as 35 g, and operation in corrosive atmospheres.



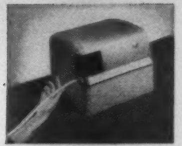
Complete message center in one Teletype machine

A complete message center in a compact cabinet, with a choice of components to best meet your individual needs—that's the story of the Teletype Model 28 automatic send-receive set.

It provides facilities for sending and receiving on message paper or sprocket-fed business forms. In addition, there is a choice of four different tape reader and four different tape punch components—for preparing punched tape and for sending and receiving with tape.

The flexibility of the set is further broadened by a built-in control unit, the "stunt box," which may be equipped for a wide variety of extra features and switching duties—eliminating the need for external apparatus often required for such functions.

The ASR set is a compact, efficient tool to speed communications and cut costly paperwork. Teletype Corporation manufactures this equipment for the Bell System and others who require the finest in data communications equipment.



Typing Tape Punch

Tape Reader

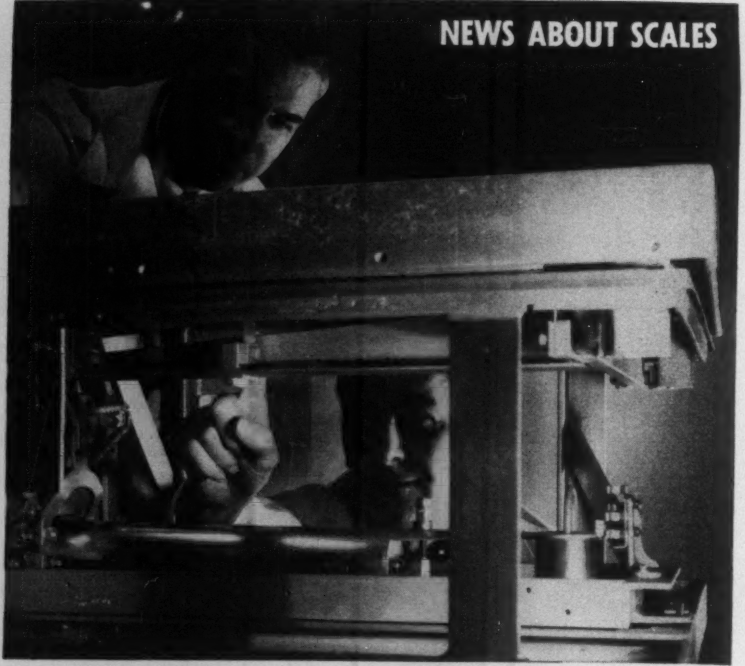
Send-Receive Page Printer

Automatic Send-Receive Set

FREE Model 28 line folder. Write Dept. 25K.
5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

Circle 674 on Page 19



How do they build unvarying accuracy into this remarkable new kind of weighing instrument?

For 7,000 years men have employed the multi-part pivot balance to compare weights. As the parts of their pivot joints wore, the problem of retaining accuracy became more and more acute. Then in 1956 the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen, aware of industrys great cumulative loss of materials in weighing operations, had devised a revolutionary new scale. Knife-edge pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem.

Thayer guarantees this leverage system accurate for the life of the scale.

How Can It Save You Money Year After Year?

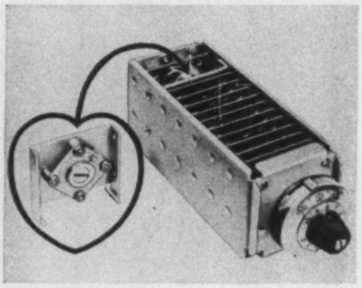
Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.

THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. THAYER PARK PEMBROKE, MASS.
A Subsidiary of SUNDSTRAND CORPORATION

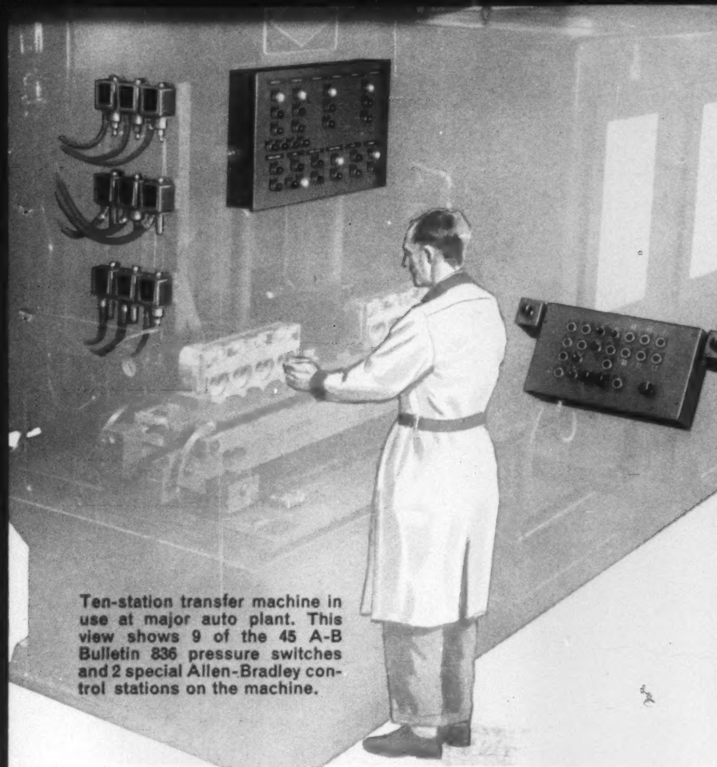
Circle 675 on Page 19



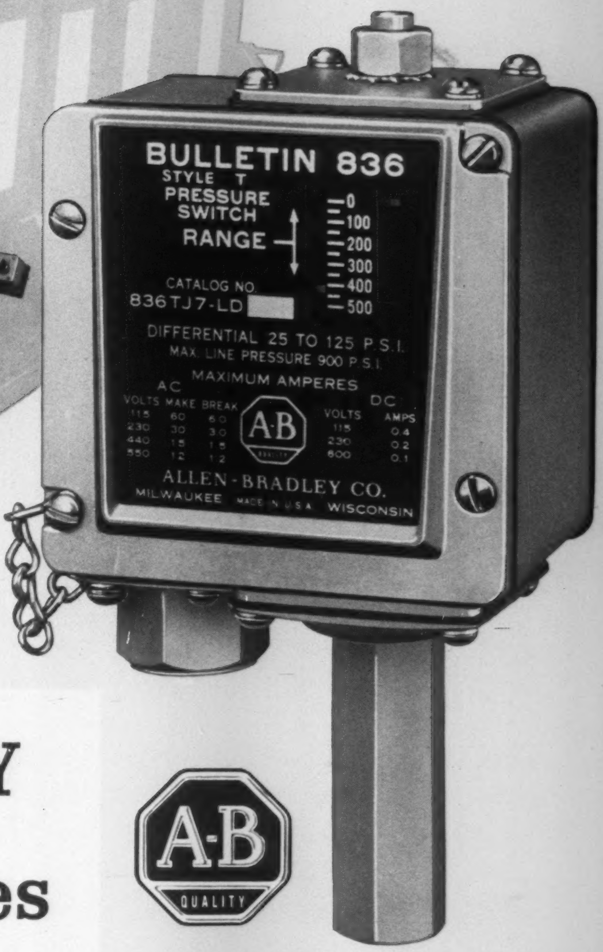
REMOVABLE-WAFER rotary switches, available from Chicago Dynamic Industries Inc., can handle up to 400 single-pole positions. Switching is transferred from one wafer to the next through a Geneva gear control unit and associated control wafer. Maintenance time is held to a minimum because the wafers lift out without unsoldering or disassembling. Thus, wafers are available for fast cleaning or immediate replacement. Standard multiposition indicating dials can be furnished.

Systems and Controls Group which is composed of Hydro-Aire Co., Chapman Valve Mfg. Co., and Swartwout Co., all divisions of the parent company. Function of the new group will be to provide an interchange of knowledge, research data, and techniques among the three companies. The new group will permit integration of individual components of the companies into complete systems for industrial and military use. . . . **Olaer Products Inc.** has established a Fluid Power Service-Center in Westbury, N. Y. The center will offer manufacturers a wide variety of services associated with the development and maintenance of fluid power components and systems for military and industrial application. . . . **Hiller Aircraft Corp.** and **Electric Autolite Co.** have announced a negotiation to merge the two companies. The merger agreement will be presented to the stockholders of both companies for final approval. . . . **Magnetics Inc.**, producer of components for the electronics and allied industries, has started construction of a $400,000 building to house expanded research and development facilities. . . . **Sonotec Inc.**, has purchased the amplifier portion of the Langevin Div., W. L. Maxson Corp. The purchase included the Langevin trademark, trade name, and certain fixed assets and inventory items. . . . **Hartman Metal Fabricators Inc.**, manufacturer of portable lift trucks and material handling equipment, have moved to larger quarters in

Circle 676 on Page 19→



Ten-station transfer machine in use at major auto plant. This view shows 9 of the 45 A-B Bulletin 836 pressure switches and 2 special Allen-Bradley control stations on the machine.


BULLETIN 836
STYLE T
PRESSURE SWITCH
RANGE
0
100
200
300
400
500
CATALOG NO.
836TJ7-LD
DIFFERENTIAL 25 TO 125 P.S.I.
MAX. LINE PRESSURE 900 P.S.I.
MAXIMUM AMPERES
AC
VOLTS MAKE BREAK
115 60 6.0
230 30 3.0
440 15 1.5
550 12 1.2
A-B
DC
VOLTS AMPS
115 0.4
230 0.2
600 0.1
ALLEN-BRADLEY CO.
MILWAUKEE MADE IN U.S.A. WISCONSIN

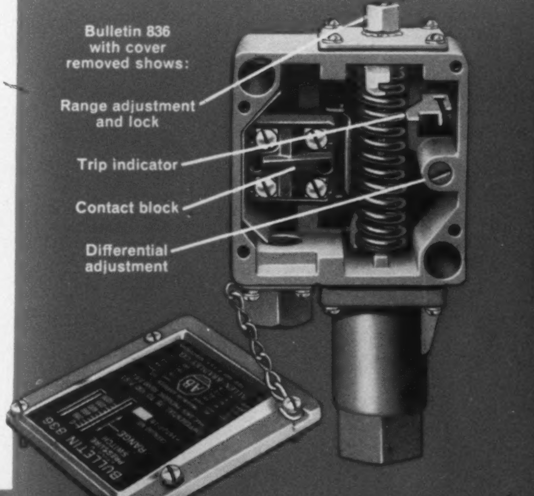
Bulletin 836 Style T
Oiltight Pressure Switch

ALLEN-BRADLEY
OILTIGHT
Pressure Switches

provide consistent accuracy and maximum reliability

These rugged Allen-Bradley Bulletin 836 Style T oiltight pressure switches are specifically designed to take the punishment of hard, day-in and day-out industrial use. The die-cast aluminum housing is completely sealed. Oil cannot get in and foul the contacts—even when it flows over the enclosure in a continuous stream. The precision switch mechanism insures extreme accuracy of repeatability. An extremely important feature lies in the "snap action" of this switch—it maintains its normal contact pressure up to the instant of switchover—regardless of how slowly the trip point is approached. Contact chatter—which means unreliable operation—is impossible, and contact life is greatly increased. The contact block has two isolated circuits with one N.O. and one N.C. set of contacts.

Both the operating pressure and the differential are adjustable. The pressure is externally adjustable with the setting shown on a calibrated scale, and a trip indicator shows the operating point. These A-B *quality* controls are made for operating at pressures up to 5000 psi. Write for full details.

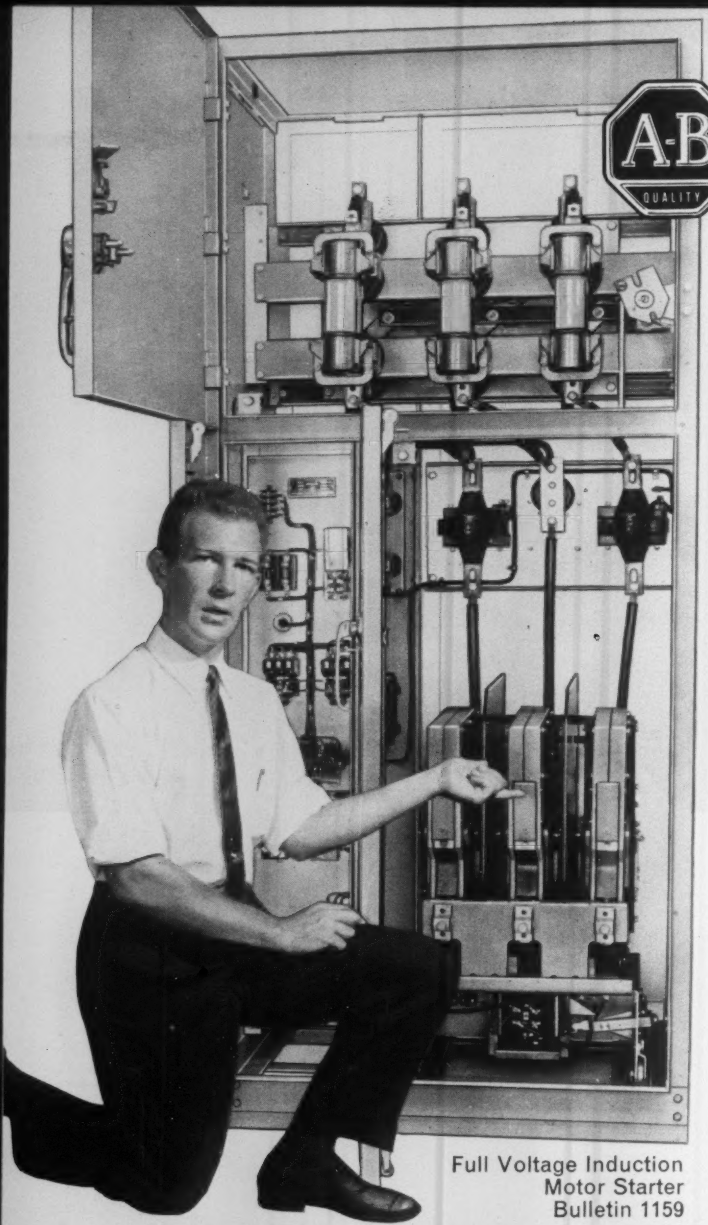

Bulletin 836 with cover removed shows:
Range adjustment and lock
Trip indicator
Contact block
Differential adjustment
BULLETIN 836

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario



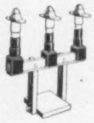
Full Voltage Induction
Motor Starter
Bulletin 1159

The only HIGH VOLTAGE STARTERS

built to provide millions of trouble free operations

An astounding claim but true! The secret of this remarkable operating life of Allen-Bradley high voltage air break starters is found in the extremely short contact travel—*it's only 3/8"*. Thus, pounding and contact wear are reduced to a minimum. In addition, contactors in A-B high voltage starters have only ONE moving part. It's the same simple solenoid design that has proved good for millions of trouble free operations in A-B low voltage starters. And like A-B low voltage starters, the double break, silver alloy contacts never need maintenance. For complete details on Allen-Bradley high voltage starters, send for Publication 6080.

FEATURES OF THE ALLEN-BRADLEY RUGGED SOLENOID AIR BREAK CONTACTOR

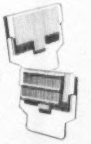


ONE MOVING PART All trouble-causing pivots, pins, and flexible jumpers are eliminated.

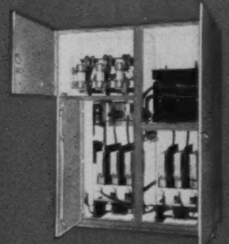
CONTACT TRAVEL ONLY 3/8" Reduced impact and pounding extends contact operating life.

DOUBLE BREAK CONTACTS of silver alloy completely eliminate the need for contact maintenance.

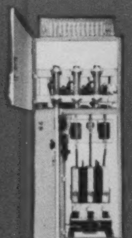
FAST ARC SUPPRESSION New blowout design, new arc chutes molded of arc resistant material.



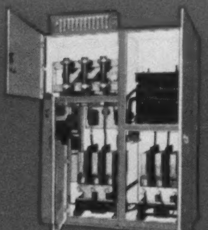
ALLEN-BRADLEY HIGH VOLTAGE STARTERS ARE MADE FOR ALL TYPES OF MOTORS AND ALL TYPES OF SERVICE



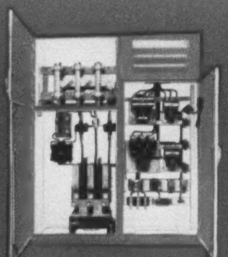
Reduced Voltage
Induction Motor Starter
Bulletin 1172



Full Voltage
Synchronous Motor Starter
Bulletin 966



Reduced Voltage
Synchronous Motor Starter
Bulletin 983



Wound Rotor Motor Starter
Bulletin 1180

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

QUALITY MOTOR CONTROL

12-60-MR

Waterloo, N. Y. . . . **Bristol Co.** has moved its Midwest branch factory and offices to larger quarters in Melrose Park, Ill.

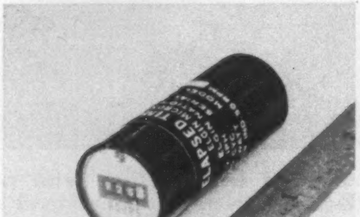
MEETINGS AND EVENTS

Oct. 3-7—
Southern Textile Exposition. To be held at Textile Hall, Greenville, S. C. Additional information available from H. H. Lesesne, P. O. Box 1970, Columbia, S. C.

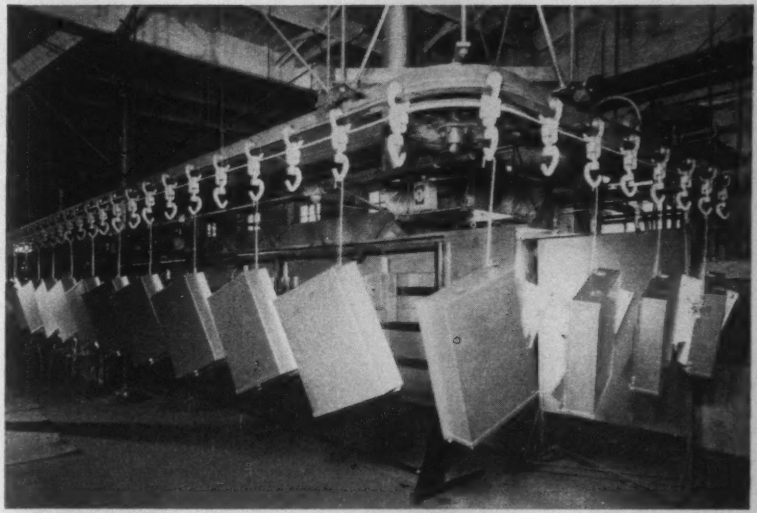
Oct. 5-6—
Electronic Industries Association. Second conference on value engineering has been rescheduled for Disneyland Hotel, Anaheim, Calif. More details available from EIA, Engineering Dept., 11 West 42nd St., New York 36, N. Y.

Oct. 9-11—
Rubber and Plastics Conference. First annual meeting sponsored by American Society of Mechanical Engineers with the co-operation of the Erie Engineering Societies Council. To be held at Hotel Lawrence, Erie, Pa. Further details available from ASME headquarters, 29 West 39th St., New York 18, N. Y.

Oct. 10-12—
National Electronics Conference. To be held at Hotel Sherman, Chi-



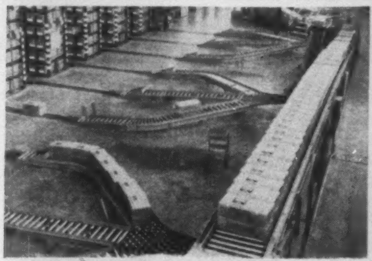
NUMERALS approximately the size of typewriter characters are featured in a miniature elapsed time indicator built by Elgin Micronics, Div., Elgin National Watch Co. This feature is said to reduce the hazard of misreading, especially when access is difficult. The readout incorporates a 50 rpm tell-tale disc and integrates 1000 hours in 0.1 hour increments or 10,000 hours in 1 hour increments. Environmental tolerance covers temperature variation from −65 to 165 F and 20g vibration over a 10-2000 cps range. Input is 28 or 115 v ac at 400 cps.

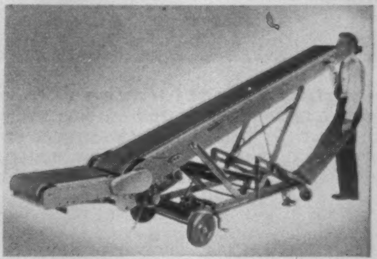


BUSCHMAN SPECIALIZATION
Pays Off In Your Plant

Buschman designs, manufactures and installs conveyors . . . good conveyors . . . *nothing but conveyors.* Specialists in the field. Whatever you buy from Buschman is experience-engineered to fit your needs: Roller conveyors, wheel, belt, live roller, overhead trolley and table-cable conveyors, slat, pusher bar, live storage racks and elevating equipment.

Buschman combines components in systems that effect greatest economy in your handling. Given Buschman engineering and stocked parts, you can install. Tell us about the handling job that faces you; we will send literature and suggestions. The E. W. Buschman Company, 4551 Clifton Avenue, Cincinnati 32, Ohio.





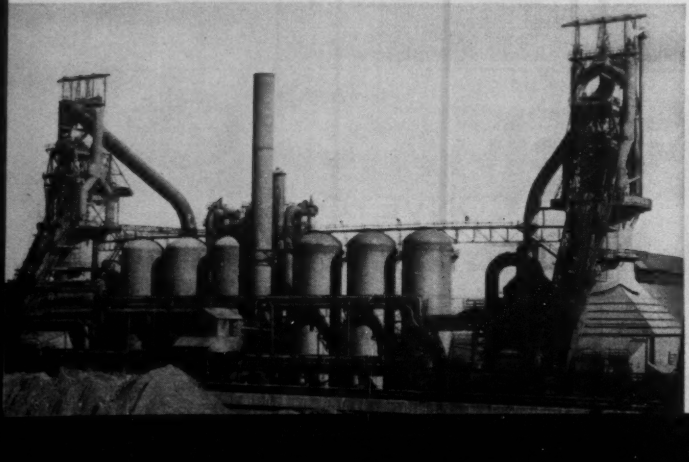
Buschman
CONVEYORS

Booth 128
CENTRAL STATES MHI SHOW - Louisville
November 1-2-3

Complete Conveyor Systems for all Industries—Engineered, Manufactured, Installed
Representatives in Principal Cities; See Yellow Pages

366

Charging a blast furnace with pushbuttons. Now there are blast furnaces that automatically charge themselves—with the right material in the proper sequence. Results? Improved production and use of raw materials. The controls and control system are Cutler-Hammer developed.



Shifting hundreds of car bodies with pushbuttons. Cutler-Hammer systems control men made it possible for one man to sort car bodies in and out of a storage area which smoothed the production of the automobiles . . . eliminated temporary shutdowns in both body and assembly plants.

CONTROL

What's new in control for automation?

New! A machine that can count and stack newspapers in the exact numbers needed

Automatic Counter-Stacker from Cutler-Hammer helps automate mail room operations . . . cuts costs drastically. You think you have distribution problems?

Think of those the metropolitan newspaper publisher faces every day in getting hundreds of thousands of papers out on the street and into the home.

To help solve this complicated situation Cutler-Hammer system control men came up with the Cutler-Hammer automatic newspaper counter-stacker. Many are working dependably at a number of big dailies already.

As the papers come off each press (up to 1000 a minute!) every paper is counted, then stacked in predetermined quantities, ready to be labeled, tied and sent to delivery trucks.

Even more helpful, these counter-stackers can be equipped with programmers being developed by Cutler-Hammer that will make it possible to vary the "count" of each bundle as it comes off the counter-stacker, so the needs of each route can be met exactly—automatically. These programmers will make the completely automated mail room possible.

Get in touch with the control man early. The sooner you can bring the control system man into your automation planning, the more he can help you. His experience with so many different control problems in so many different kinds of industries can save you time, save you money, increase efficiency.

What's new at Cutler-Hammer? We've geared up for the sixties in a big way. We've added new engineering talent, developed new and better products, expanded plant capacity. If you're planning ahead, let's get together. Maybe we could help you plan ahead faster and better. Get in touch with the Cutler-Hammer sales office nearest you.

Automation is more efficient when the Cutler-Hammer man is called in early.

WHAT'S NEW? ASK...

CUTLER-HAMMER

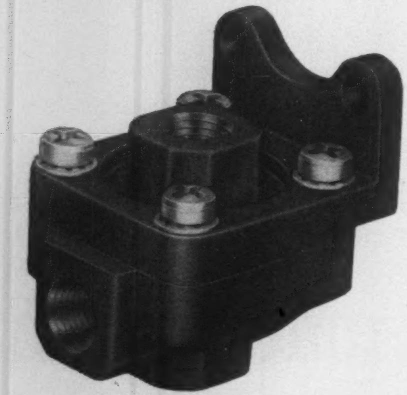
Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

CONTROL

Circle 679 on Page 19

Another new Westinghouse

AIR CIRCUITRY Component

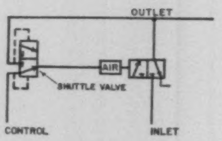


SHUTTLE VALVE

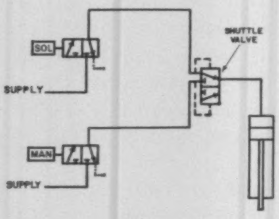
The Westinghouse Shuttle Valve automatically selects and directs the flow of air from one or the other of two controlling devices to a common outlet. It serves to connect two independent lines to a common line without destroying the segregation. A few of its uses are shown below.

Simple—Lightweight—Sensitive It contains only **one** moving part—an easily replaceable rubber diaphragm. Two body segments, a gasket and four screws complete the assembly. It has no springs. Nothing can bind or stick. Its compact size presents no installation problem.
Weighing only **6 ounces,** it can easily be supported by piping alone. Mounting feet are included, however, for installation with vibration or long pipe runs. It is so sensitive that it will seal off the opposite inlet line with less than 1 psi pressure differential.

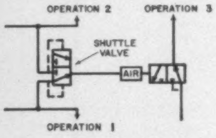
TYPICAL APPLICATIONS



LOCK-UP
Insures an operation is held constant once initiated. Outlet line must be vented by another means to unlock the system. ("Memory" Circuit)



TWO-STATION CONTROL
Either of two controlling devices may operate the cylinders. Inoperative controlling device is sealed from the line. ("Or" circuit)



INTERLOCK
Prevents operation #3 when operation #1 or #2 is in process. ("Not" circuit)

AIR CIRCUITRY means trouble-free automation

Air Circuitry is the application of pneumatic control systems to industrial production operations.

Air circuits are safe, economical and precise and are used to solve the most rigorous and complex control problems in industry.

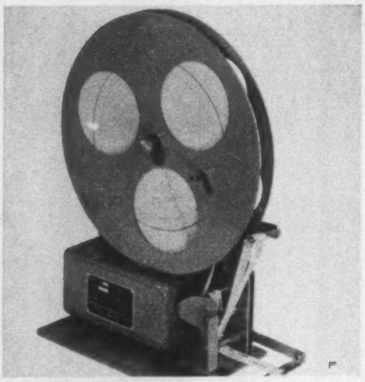
Our engineers, backed by 90 years of experience, can help you boost production and cut costs in your plant.

For more information, ask for Data Sheet A6-104-02

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle 680 on Page 19



PORTABLE tape winder can be operated on any flat surface. Equipped with a 12-inch metallic reel, the tape winder, designed by Western Apparatus Co., Div., Comptometer Corp., holds up to 1300 feet of chadless and up to 2000 feet of fully perforated tape. Winding tension is adjustable to obtain maximum tightness without tearing the tape. The reel is magnetically held to the rotating frame for simple, snap-off removal. The tape is removed by rotation of the two sides of the reel.

cago. Exhibits and technical papers to be presented. Information available from John S. Powers, Chairman NEC, 228 N. La Salle St., Chicago 1, Ill.

Oct. 10-12—

Systems and Procedures Association. International meeting to be held at Hotel Commodore, New York. Information from society headquarters, 4463 Penobscot Bldg., Detroit 26, Mich.

Oct. 10-14—

Society of Automotive Engineers Inc. National aeronautic meeting, manufacturing forum, and engineering display to be held at Ambassador Hotel, Los Angeles. More details from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Oct. 12-14—

Industrial Management Society. Industrial engineering and management meeting to be held at Conrad Hilton Hotel, Chicago. More information from IMS headquarters, 330 South Wells St., Chicago 6, Ill.

Oct. 16-19—

Scientific Apparatus Makers Association. Meeting on industrial instruments. To be held at the Broadmoor Hotel, Colorado Springs, Colo. More information from asso-

Another first from Standard Conveyor

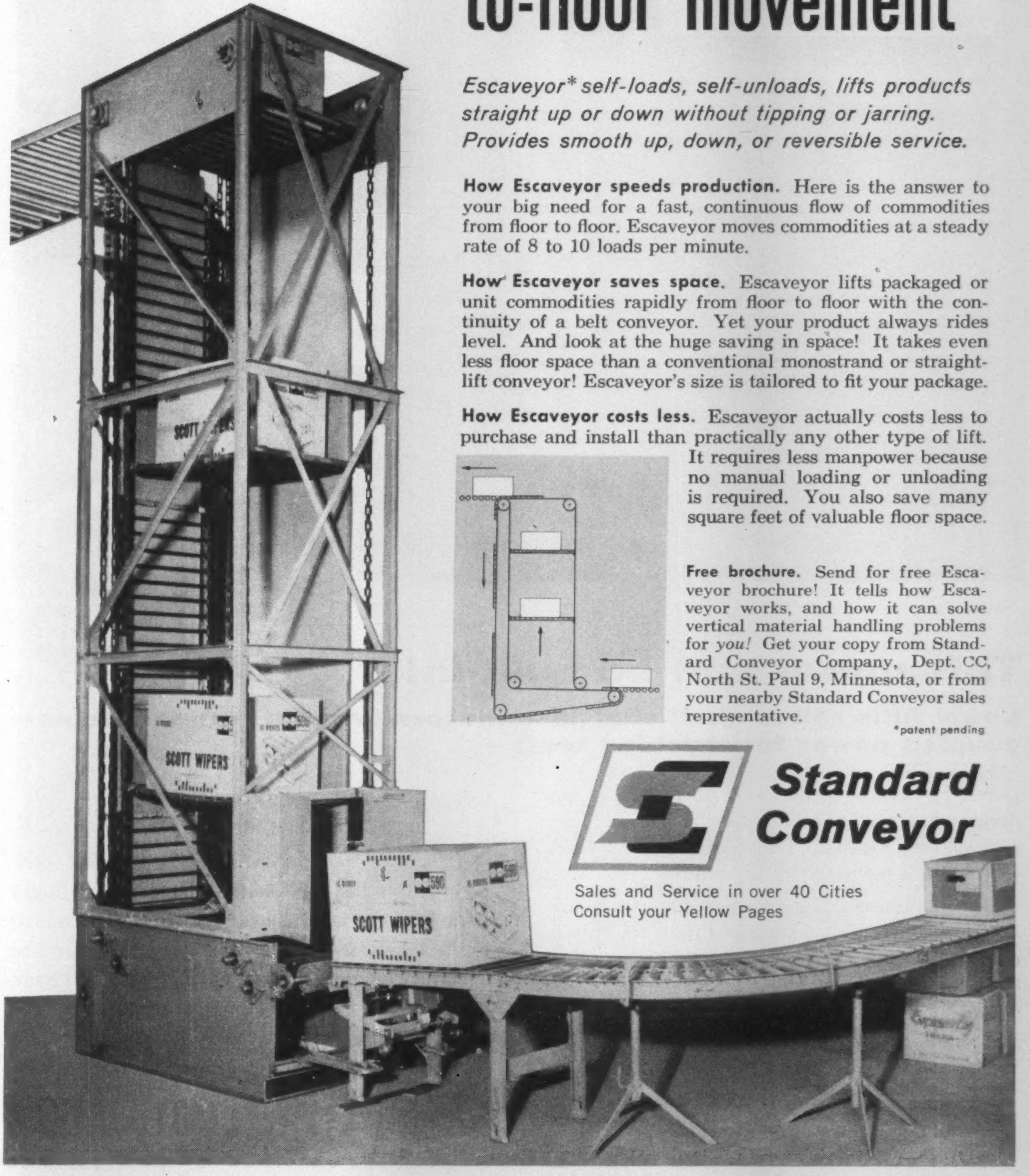
New continuous vertical conveyor revolutionizes floor-to-floor movement

Escaveyor self-loads, self-unloads, lifts products straight up or down without tipping or jarring. Provides smooth up, down, or reversible service.*

How Escaveyor speeds production. Here is the answer to your big need for a fast, continuous flow of commodities from floor to floor. Escaveyor moves commodities at a steady rate of 8 to 10 loads per minute.

How Escaveyor saves space. Escaveyor lifts packaged or unit commodities rapidly from floor to floor with the continuity of a belt conveyor. Yet your product always rides level. And look at the huge saving in space! It takes even less floor space than a conventional monostrand or straight-lift conveyor! Escaveyor's size is tailored to fit your package.

How Escaveyor costs less. Escaveyor actually costs less to purchase and install than practically any other type of lift. It requires less manpower because no manual loading or unloading is required. You also save many square feet of valuable floor space.

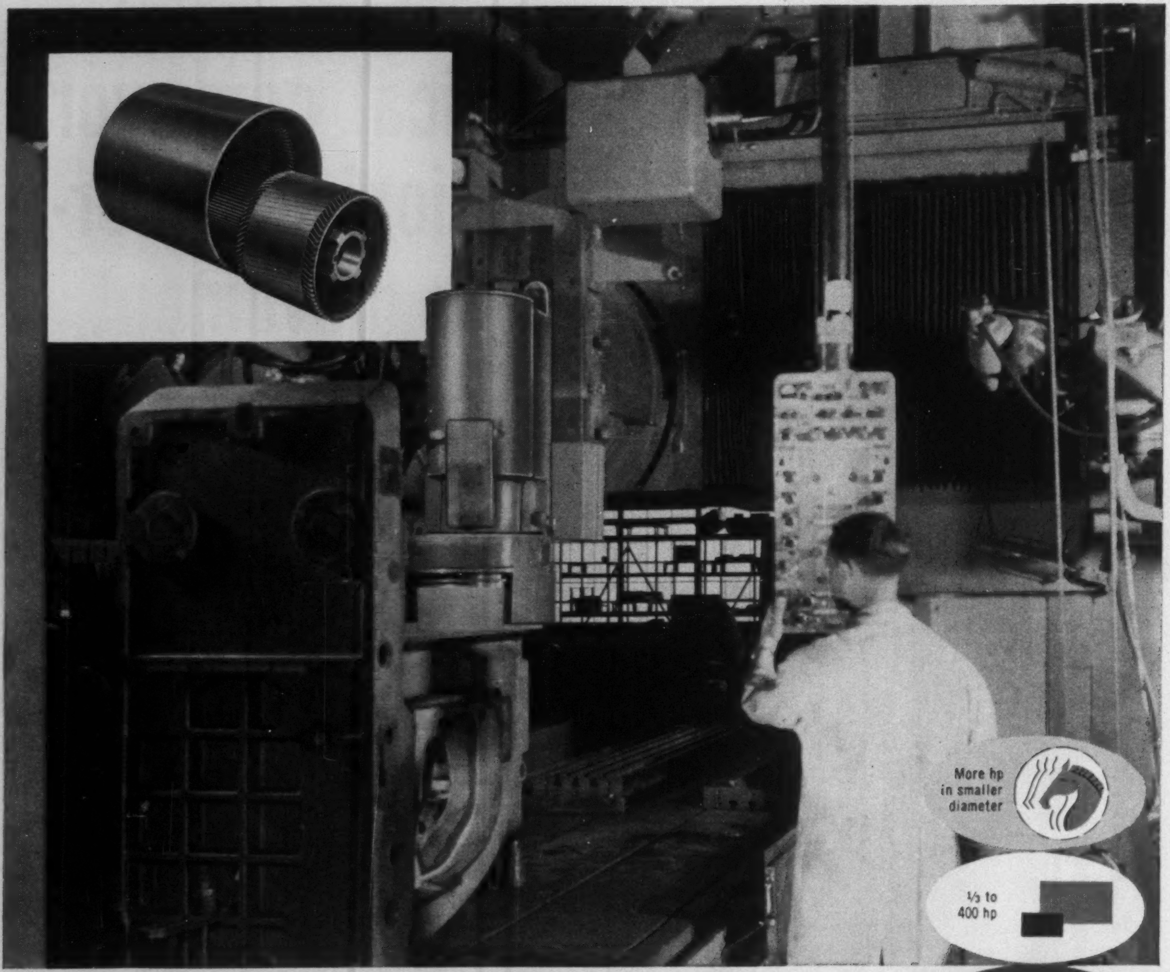


Free brochure. Send for free Escaveyor brochure! It tells how Escaveyor works, and how it can solve vertical material handling problems for *you!* Get your copy from Standard Conveyor Company, Dept. CC, North St. Paul 9, Minnesota, or from your nearby Standard Conveyor sales representative.

*patent pending

Standard Conveyor

Sales and Service in over 40 Cities
Consult your Yellow Pages



This motor can be built-in!

Louis Allis rolled-shell shaftless motors provide compact, close-coupled power for machine tools

Here's just one of many Louis Allis special motor designs that machine tool builders respect and users appreciate. It's a 30 hp, 1200 rpm rolled-shell shaftless motor — pioneered by Louis Allis.

The motor consists of a precision stator in a steel shell and an accurately machined rotor that can be mounted directly on machine tools like the rotary surface grinder shown above.

The compact motor allows closer spacing of spindles and shafts. It reduces the weight and size of the machine — blends the motor into the machine contour. Its design flexibility enables you to use direct drives for separate machine functions — to select motor characteristics best suited for each operation.

Louis Allis rolled-shell shaftless motors range in size from ⅓ to 400 hp. They can be furnished with high torques, low losses for grinder duty, vibration-free operation, and other special modifications. For more information — for engineering assistance — call your Louis Allis District Office. Or write The Louis Allis Co., 463 E. Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

SM-107

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Circle 682 on Page 19

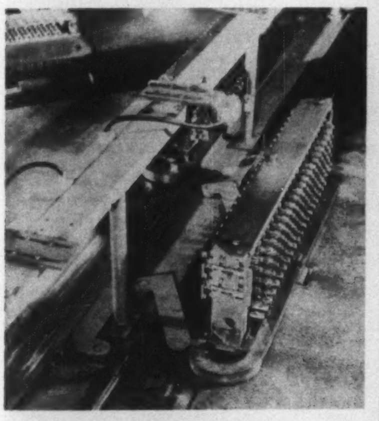
ciation headquarters, 20 N. Wacker Dr., Chicago 6, Ill.

Oct. 17-19—
Lubrication Conference. Co-sponsored by American Society of Mechanical Engineers and American Society of Lubrication Engineers. To be held at Statler Hilton Hotel, Boston. Additional information from ASME headquarters, 29 West 39th St., New York 18, N. Y.

Oct. 17-21—
American Society for Metals. National Metal Congress and Exposition to be held at Philadelphia's Trade and Convention Center. Details available from ASM headquarters, Metals Park, Novelty, Ohio.

Oct. 27-28—
1960 Electron Devices Meeting. Sponsored by Institute of Radio Engineers. To be held at Shoreham Hotel, Washington. Additional information from D. H. W. Welch, Motorola Inc., 8201 E. McDowell Rd., Phoenix, Ariz.

Oct. 31-Nov. 2—
Packaging Institute Inc. 22nd annual National Packaging Forum



STEEL BELT conveyors supplied by Sandvik Steel Inc. are used to carry heavy, bulky switching apparatus through assembly operations at Western Electric Co. Inc. The conveyors are made of strips or bands of carbon steel that have been trued and flattened. Two parallel conveyors are built into each assembly table to carry the parts from one workstation to the next. To facilitate handling, the switches travel upright on special roller-mounted fixtures. The fixtures are rolled onto a conveyor at one end of the table, and are automatically pushed off at predetermined workstations by pneumatically-operated pusher arms located between the belts.

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FIRST NAME IN ELECTRIC HEAT
Cleaning and degreasing solutions.
Quenching oil.
Forced-pressure lubricating systems.

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Heat liquids
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CHROMALOX
ELECTRIC HEAT

Fast, uniform, economical, safe

Just drill and install threaded pipe coupling in tank, then screw in the Chromalox Immersion Heater. Built-in thermostat automatically maintains uniform temperature of water, oils, paraffin, wax, various solutions. Several styles available, for different applications. Elements sheathed in copper or steel. Standard ratings from 50° to 550°F., ¾ to 10KW, 120 or 240 volts. Inside-tank extensions from 6¼" to 48". Available with explosion-resistant and moisture-resistant terminal box. Prices start under $20.

For more details, call your Chromalox Sales-Engineering Representative, or write us for Bulletin PD105, which contains specifications and prices.

91891

Call Your Chromalox Man for Heating Answers

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Hopkins 7-3280
BLOOMFIELD, N.J.
Edison 8-6900
New York: Worth 4-2990
BOSTON, MASS.
Cedar 5-8040
BUFFALO, N.Y.
TT-6-4000
CHARLOTTE, N.C.
Edison 4-4244
Franklin 5-1044
CHATTANOOGA, TENN.
Amherst 5-3862
CHICAGO, ILL.
Harrison 7-5464
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Trinity 1-0605
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Phone 3-7706
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Prospect 1-7112
COLUMBUS, OHIO
Amherst 7-8260
DALLAS, TEX.
Riverside 8-9004
DAVENPORT, IOWA
Phone: 6-5233
DENVER, COLO.
Glendale 5-3651
Genesee 3-0821
DES MOINES, IOWA
Cherry 3-1203
DETROIT, MICH.
(See Southfield, Mich.)
HOUSTON, TEX.
Capitol 5-0356
INDIANAPOLIS, IND.
Melrose 5-5313
KANSAS CITY, MO.
Victor 2-3306
LOS ANGELES, CAL.
Ludlow 9-6321
MIDDLETOWN, CONN.
Diamond 6-9606
MILWAUKEE, WIS.
Broadway 1-3021
MINNEAPOLIS, MINN.
Federal 6-6631
NASHVILLE, TENN.
Cypress 2-7016
NEW YORK CITY, N.Y.
(See Bloomfield, N.J.)
OMAHA, NEB.
341-7600
PHILADELPHIA, PA.
(See Bala-Cynwyd, Pa.)
PITTSBURGH, PA.
Emerson 1-2900
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RICHMOND, VA.
Atlantic 8-8758
ROCHESTER, N.Y.
Hamilton 6-2070
ST. LOUIS, MO.
Chestnut 1-2433
SAN FRANCISCO, CALIF.
Underhill 1-3000
SEATTLE, WASH.
Main 4-7297
SOUTHFIELD, MICH.
Kenwood 8-2100
Elgin 7-0677
SYRACUSE, N.Y.
Granite 4-3933
WICHITA, KAN.
Amherst 2-5647

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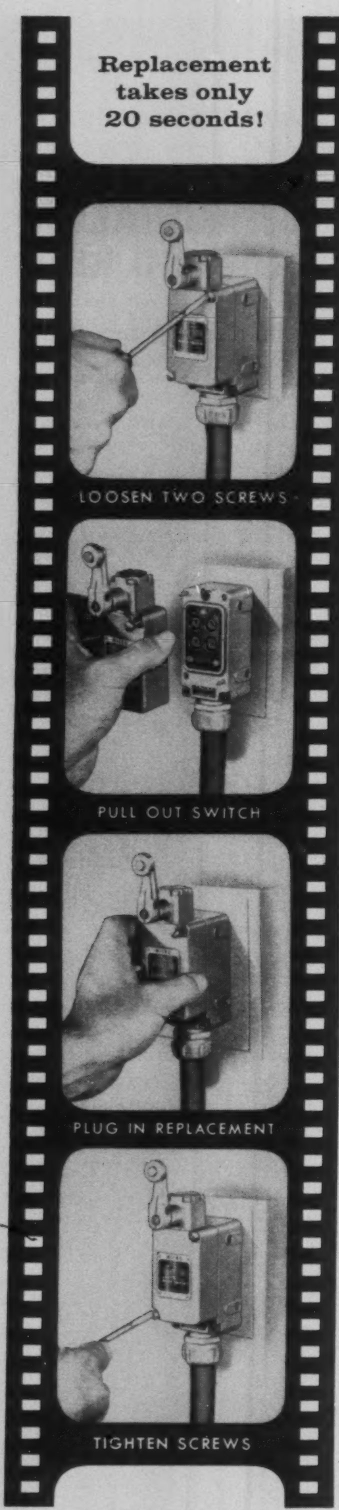


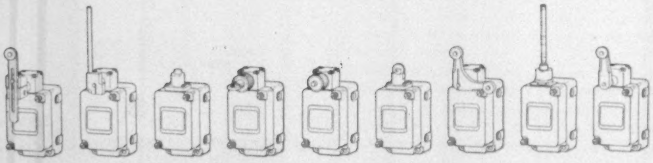
MICRO'S "Plug-in Limit" switch saves production time, adds new versatility!

The "200LS" series switches can be replaced in just 20 seconds. In some applications where limit switches take abnormal abuse, production engineers have actually translated this time savings into as much as a 6% increase in production. Replacement is as easy as plugging in a radio tube.

These "Plug-in Limit" switches have many other advantages. You can automatically disconnect any station on your production line by simply pulling the correct plug-in switch. Nine different actuators are available, and all fit one receptacle size. Thus receptacles need not be replaced, and you simply plug in your choice of actuator quickly and easily.

One basic switch is interchangeable for all models in the "Plug-in Limit" series.

MICRO SWITCH offers the largest selection of plug-in switches available. Ask your MICRO SWITCH distributor to show you these timesavers. You'll appreciate their rugged, simple construction, and he can show you how they can save you money on your production line.



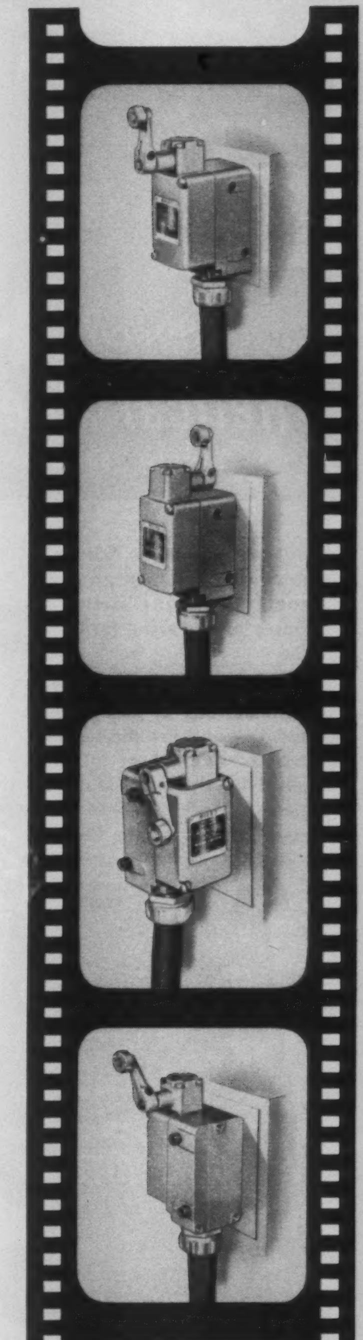
HONEYWELL **MICRO SWITCH Precision Switches**

The inside story . . . timesaving simplicity!

The spring plugs are integrally molded to the precision snap-acting switch body. Plug-in action is safe and sure due to the sturdy, molded barriers which protect the plugs. The rugged terminal receptacle has heavy No. 8 terminal screws for easy wiring. The best of protection from oil-tight seals between head and body, on actuating shaft and around the receptacle opening. Actuator head mounts in four positions. MICRO SWITCH reliability plus the plug-in design make this the most effective limit switch available. Write for Catalog 84 which describes our entire series of industrial limit switches.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

HONEYWELL
Honeywell
MICRO SWITCH Precision Switches



24 different mounting arrangements!

75th YEAR HONEYWELL
PIONEERING THE FUTURE

Fast Delivery on Custom Requirements

Specify H&S Helical Speed Reducers

Single · Double · Triple Reduction

You get *fast action* when you come to Horsburgh & Scott with your speed reducer and gearing problems.

We are able to meet your specifications—or design and build to your specific needs—products of highest quality, backed by the experience and reputation of many years as leaders in the gearing field.

Maintaining one of the largest stocks of patterns and blanks . . . special equipment and special tooling—much of it designed and built in our own plant—enables us to engineer and produce a wide range of custom gearing and transmission requirements, economically and practically as fast as you can obtain them from stock sources.

Overall design conforms to AGMA specifications

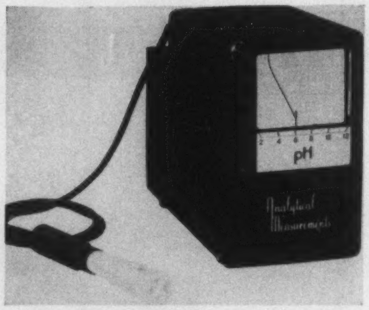
Write for details on wide size and capacity range of H&S Speed Reducers—Helical, Herringbone, Worm Gear and combinations.

The HORSBURGH & SCOTT CO.

5112 Hamilton Avenue • Cleveland 14, Ohio

Specializing in fast production of quality Speed Reducers and Gearing to meet custom requirements.

Circle 685 on Page 19



COMBINED pH meter and strip chart recorder developed by Analytical Measurements Inc. contains a 63-foot roll of chart paper that will last for 31 days at a chart speed of 1 inch per hour. Paper is coated with pressure sensitive material so that no ink is required. With chart drive disconnected, instrument becomes an indicating pH meter.

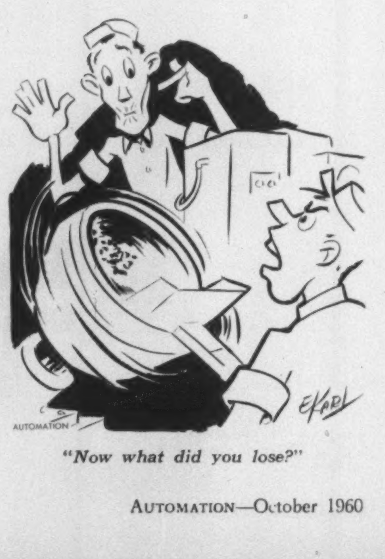
scheduled for Statler Hilton Hotel, New York. More information from the institute headquarters, 342 Madison Ave., New York 17, N. Y.

Nov. 1-3—

Material Handling Institute. Exposition and technical conferences. To be held at Kentucky Fair and Exposition Center, Louisville, Ky. Additional information available from registration chairman, Robert L. Fisher, P. O. Box 12155, Louisville 12, Ky.

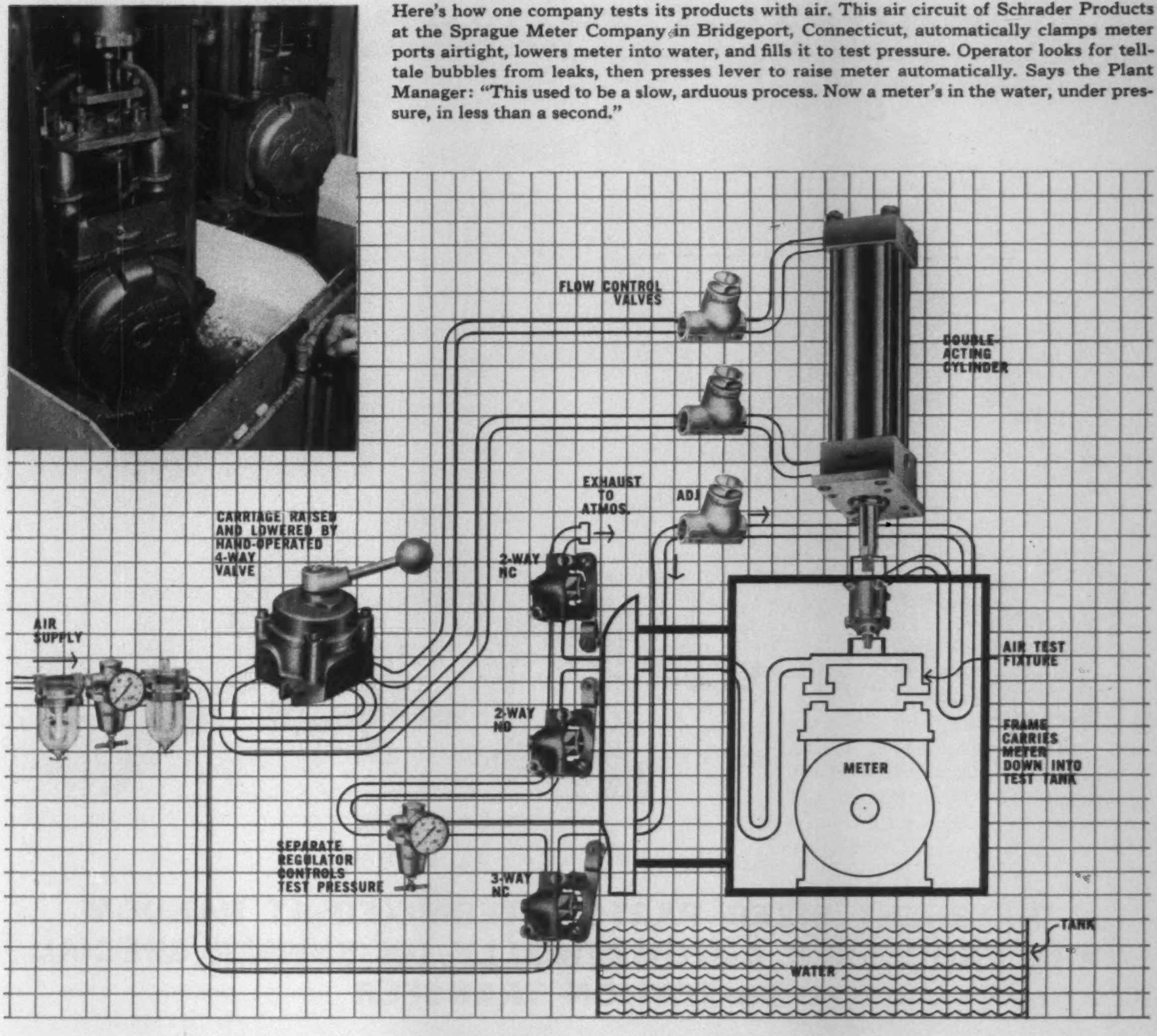
Nov. 7—

Society of Plastics Engineers Inc. Technical conference on plastics and automatic controls to be held at King Edward Sheraton Hotel, Toronto, Ontario, Canada. More information available from society headquarters, 65 Prospect St., Stamford, Conn.



"Now what did you lose?"

Here's how one company tests its products with air. This air circuit of Schrader Products at the Sprague Meter Company in Bridgeport, Connecticut, automatically clamps meter ports airtight, lowers meter into water, and fills it to test pressure. Operator looks for telltale bubbles from leaks, then presses lever to raise meter automatically. Says the Plant Manager: "This used to be a slow, arduous process. Now a meter's in the water, under pressure, in less than a second."


FLOW CONTROL VALVES
DOUBLE-ACTING CYLINDER
EXHAUST TO ATMOS.
ADJ
CARRIAGE RAISED AND LOWERED BY HAND-OPERATED 4-WAY VALVE
2-WAY NC
AIR SUPPLY
AIR TEST FIXTURE
2-WAY NO
FRAME CARRIES METER DOWN INTO TEST TANK
METER
SEPARATE REGULATOR CONTROLS TEST PRESSURE
3-WAY NC
TANK
WATER

MANUFACTURER SETS UP CRITICAL TEST IN LESS THAN ONE SECOND— WITH SCHRADER AIR PRODUCTS

As products grow more complex and precise, many manufacturers are *simplifying* their operations—with air cylinders, valves, fittings and simple schematic planning. They're installing their own circuits, as this manufacturer did, or letting Schrader experts help. For example, Schrader Air Products can inspect, test, assemble, package — do work faster, more accurately — save effort and money.

Never forget air can make almost any motion human hands can — push, pull, hold, position, or move repetitively. And air doesn't get tired — has more powerful muscles. Maintenance? Almost nil.

Take full advantage of your air power by automating with Schrader — the most complete line of Air Cylinders, Valves, and Accessories. Schrader engineers have experience and know how to help you cut your operating costs.

Select your automating equipment from the full Schrader line. Your Schrader distributor can help you pinpoint what you need. For more data, write:

Schrader®
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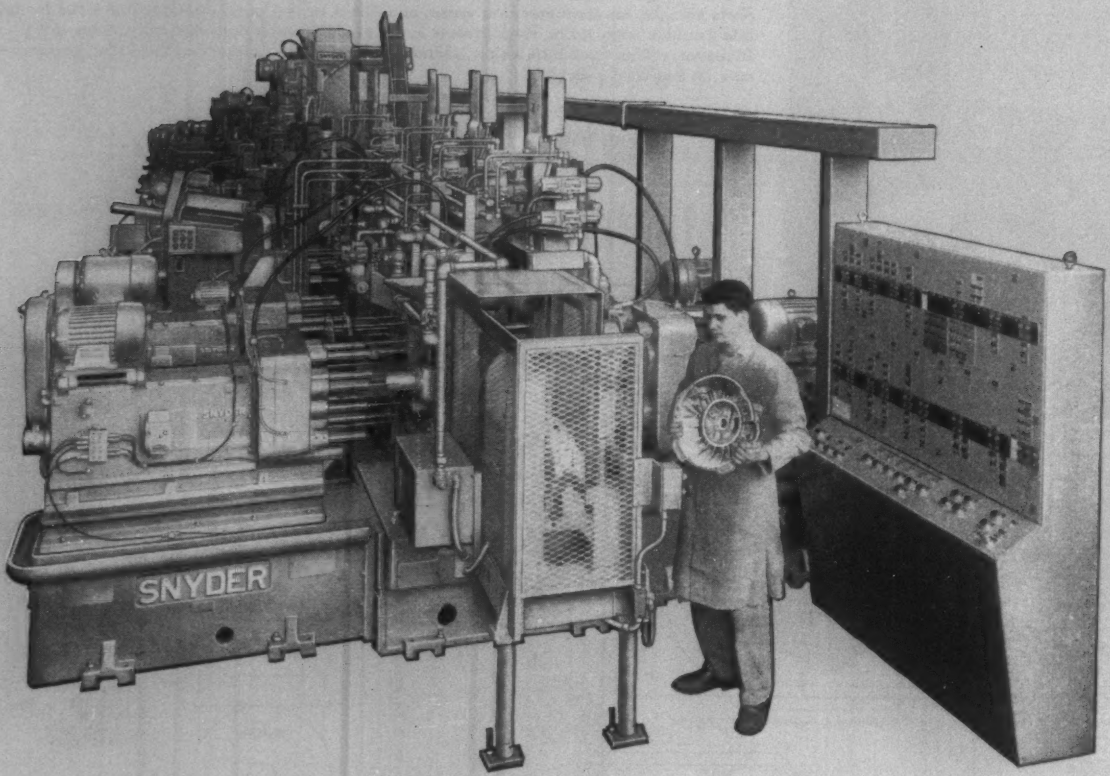
Division of Scovill Manufacturing Company, Incorporated
472 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS



DIFFERENT SIZED PARTS INTERMIXED AT RANDOM ARE PROCESSED AUTOMATICALLY ON SNYDER SPECIAL 56-STATION TRANSFER

Here's another big Snyder special "building-block" transfer with a bit of extra versatility.

Specifications called for one sequence of operations on a big aluminum transmission cover case for domestic use and a different sequence on a smaller cover for export.

Schedules set a production rate of about four domestic units to one export unit but, for production convenience, the machine had to accept these parts intermixed at random and run them through automatically.

So, Snyder Engineering designed a "collar" which bolts to the smaller piece, bringing it up to locating and clamping dimensions of the larger piece. Lugs on the collar and workpiece control appropriate switches which by-pass certain operations. Parts are automatically positioned in process.

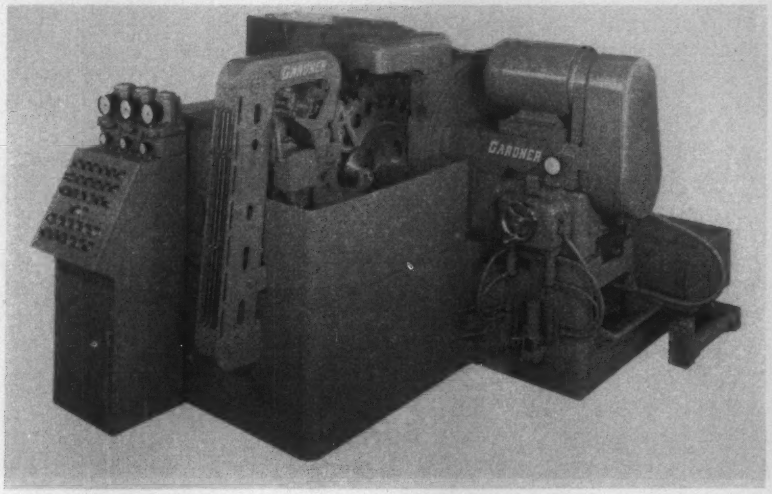
Operations include drilling, reaming, boring, tapping, chamfering, spotfacing, center holing, end milling, probing, air gaging, pressing in rectangular plug, pressing in bushing and a couple of washing operations.

Production is 150 parts an hour at 100% efficiency. Any of the 20 segments can easily be converted for comparable operations on other parts and the number of segments can be increased or reduced at any time. Your inquiries are invited.

SNYDER
CORPORATION
(Formerly Snyder Tool & Engineering Company)

3400 E. LAFAYETTE—DETROIT 7, MICHIGAN
Phone: LO 7-0123

By JAMES C. KEEBLER Managing Editor



Precision double horizontal spindle disc grinder made by Gardner Machine Co. was shown at The Machine Tool Exposition-1960 with recirculating device to enable simulation of continuous production of grinding operations on ends of universal joint spiders. Manufacture of these workpieces requires that ends be ground parallel with opposite end, square with axis of adjoining trunnion diameter, and equidistant from the centerline of the cross. Machine was specially engineered with handling and control devices to solve this production problem and function as an integral part of an automated production line.

Educate, Automate, Speculate

LAST MONTH the National Machine Tool Builders' Association staged a spectacular in Chicago. Every five years these competitors show their latest wares to the trade in an effort to bring men of industry up to date on the recent developments.

It's Not Too Late . . .

This is an educational experience that has different meanings for different people, depending to a large degree on what they already know. The object of the game was to arrange things so that no matter who you are you would come away having learned something about machine tools. Hopefully this something would include certain elements that would induce you to buy some of the products on display.

Many companies in this Association suffered pre-show doldrums in their sales curves, and went to Chicago with the same high hopes of anticipation that an automaker has before the introduction of the new models. It was optimistically assumed that the customer's recent reluctance was spurred by his desire to wait and see what the whole industry had to offer.

Surely the enthusiasm that accompanies the revelation of so many new models will catapult the prospect into being a customer with a feeling of urgency that accompanies the knowledge that if he doesn't buy now, lots of other people will soon be ahead of him. How effective this educational program was will be measured by the industry's sales statistics of the months to come.

. . . to Educate,

It costs a lot of money to move into the Amphitheatre for a two weeks stand and move back out again. The expense of setting up the classrooms must be borne by the profits of having educated customers.

Considerable special effort was put to the school of automaking. Classes were ferried in to get certain red carpet treatment and shown the results of many hours of lab work.

Although the main theme of the 1960 course was numerical control (still spelled "new miracle" control by some freshmen) there were a wide variety of subjects in the curriculum.

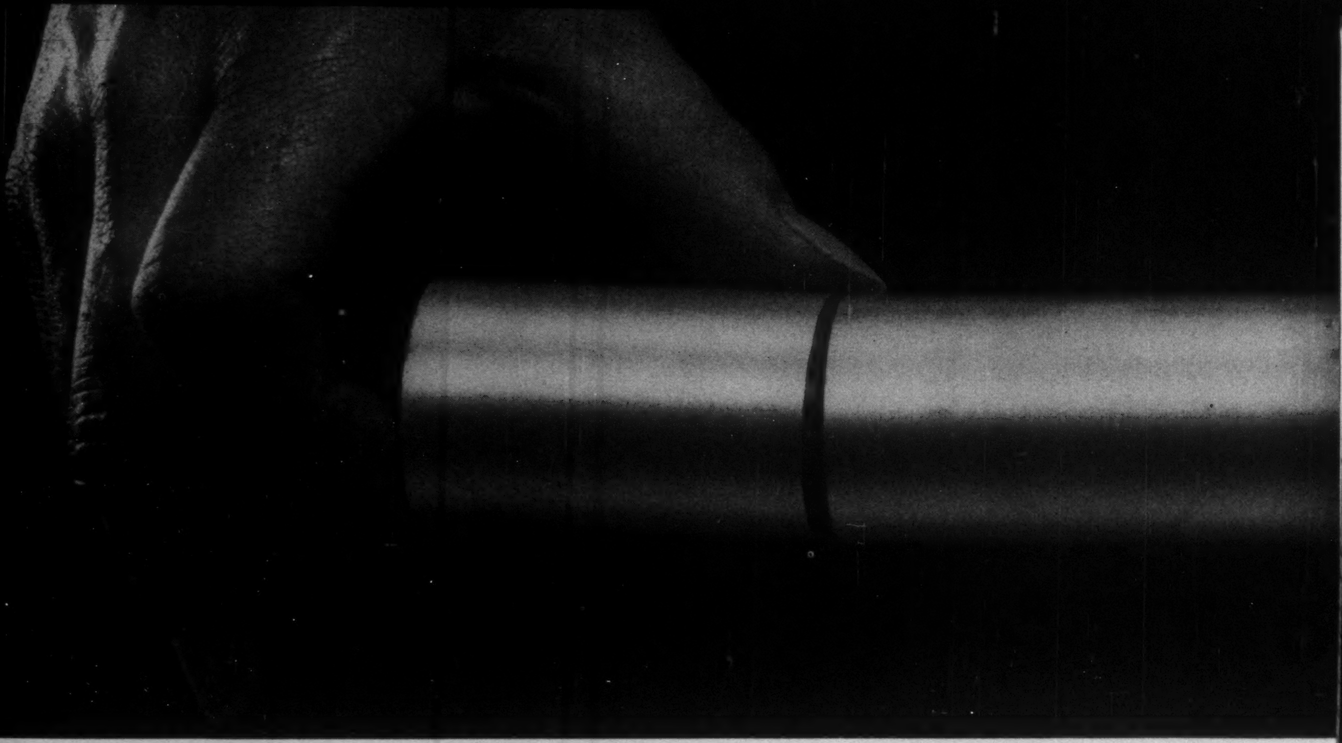
Automate . . .

Exhibits on hand showed that many of the members of the NMTBA have taken giant steps to solve some of the problems that have been plaguing their industry. When it comes to numerical control, the teachers have apparently been reading the textbooks. Now some are using this technique to make the component parts of machine tools.

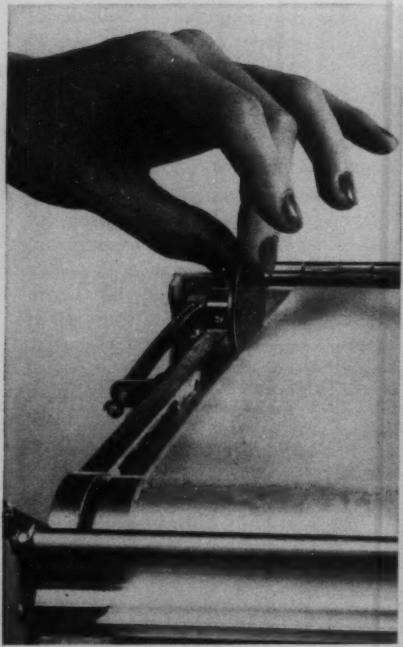
This is a big vote of confidence for the product you are peddling, to say to the prospect, "This stuff is so good we use it ourselves." Achievements in the order of five hours saved out of a former six are impressive indeed.

Although automakers are not yet buying this mode of control for high production machines they are certainly taking a second look at this subject that some had first considered to be strictly for some other school. The curious learner had to fight his way through a crowd of curious learners to ask Ray Young at the Seneca Falls booth if that lathe could really turn steps on that shaft to the various dimensions that were simply set on a panel full of dials. "You mean we just reset the dial to get a different size?," was the question of the hour.

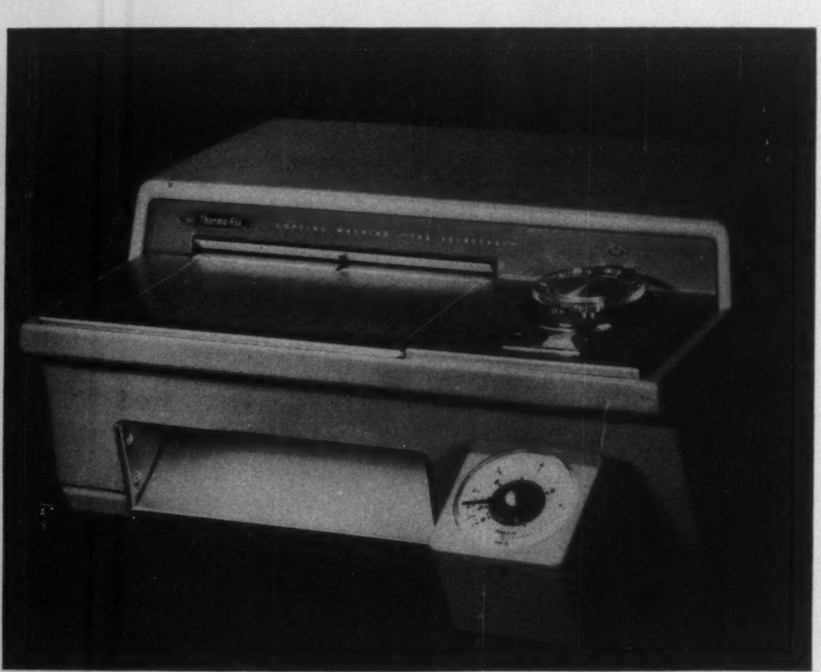
In all the halls, the marvels of NC were being unfolded. Tapes and cards were putting out input information and slides and spindles were responding to these signals. In the heat of the first week some of the electronic gear cooked too hot



Belt alignment assured in



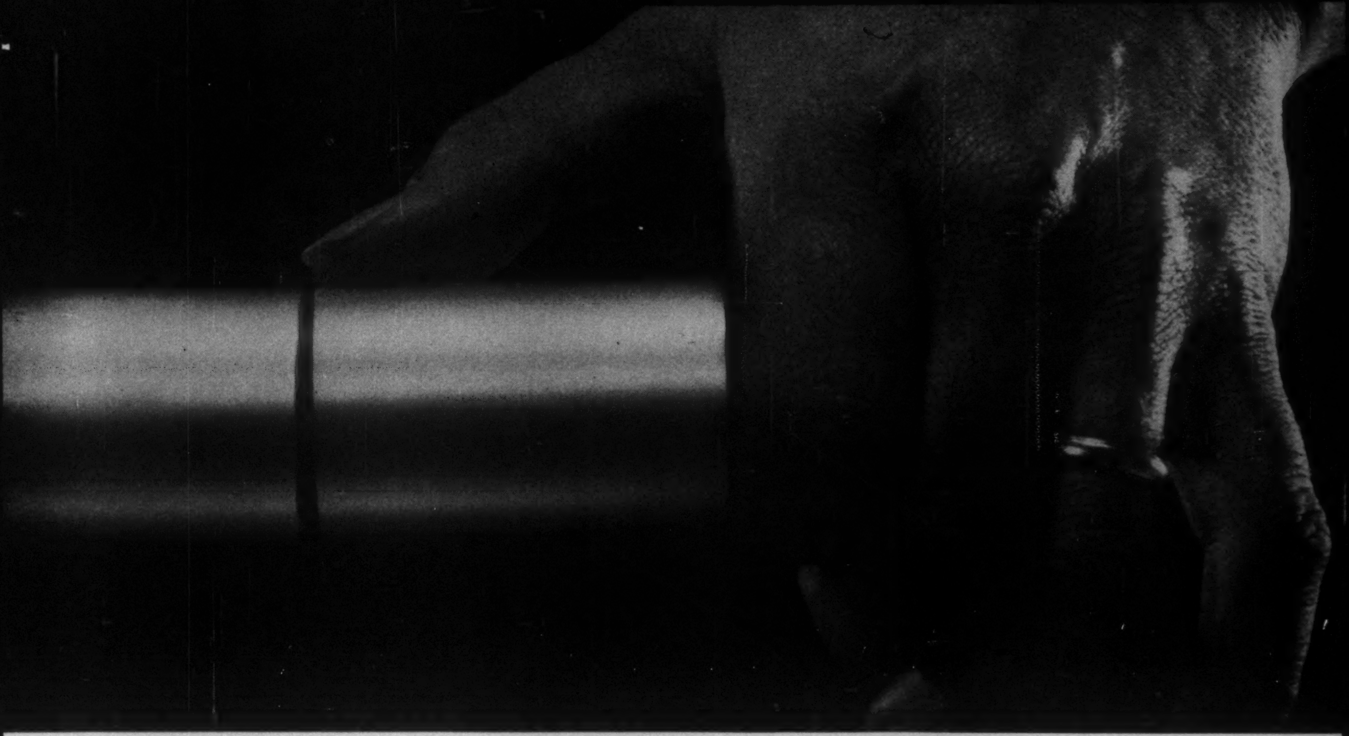
Thickness of a silver dollar indicates the close tracking tolerance of the belt which is 24 inches in circumference.



Thermo-Fax BRAND COPYING MACHINES

3M COMPANY

The THERMO-FAX "Secretary" Copying Machine, built by Minnesota Mining & Manufacturing Company using LORIG-ALIGNER Self-Centering Rolls. The terms "Thermo-Fax" and "Secretary" are registered trademarks of the 3M Company, St. Paul 6, Minnesota.



The tilting end sections of the LORIG-ALIGNER roll exert a strong self-centering action that keeps belt in alignment.

"Thermo-Fax" Copying Machines
BRAND

designed with Lorig-Aligner Self-Centering Rolls This THERMO-FAX "Secretary" Copying Machine has a plastic belt, 24 inches in circumference and 9⅜ inches wide, that must travel in almost perfect alignment for the optimum in reproduction. Early models used complicated tracking mechanisms, including motors and limit switches.

Then by using LORIG-ALIGNER Self-Centering Rolls, designers produced a simplified machine, eliminating a number of costly parts. The belt stays in alignment, sizable savings in manufacturing costs are realized, and greater reliability of service is obtained.

This mark tells you a product is made of modern, dependable Steel.

Where LORIG-ALIGNER Self-Centering Rolls can be used to obtain greater production. On metal strip processing lines, conveyor systems, grinding machines with belts, textile machines, paper-making machines, in fact, any place involving the alignment of a belt or web. Just send the coupon for the complete story.

USS and LORIG-ALIGNER are registered trademarks of United States Steel

United States Steel
Room 2801, 525 William Penn Place
Pittsburgh 30, Pa.

Please send your booklet, "LORIG-ALIGNER Self-Centering Rolls" to:

Name________________________________

Title________________________________

Company______________________________

Address______________________________

City________________State____________
(Please Print)

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company
United States Steel

and conked out. Rumor had it that everyone's system (but the guy's being interviewed) had been unable to stand the gaff. This appeared to be the position of everyone being interviewed. One cool head suggested that a more valid survey could be held in the middle of the night.

Despite the fact that running figures mentioned ran all the way from 95 per cent from a more optimistic control supplier to 70 per cent from a quite pessimistic user, there seemed to be ample evidence to show that the savings achieved from use of NC could not only buy the equipment, but also absorb the cost of keeping it running. Most agree that the user has a lot to learn before he can do that efficiently.

. . . and be Competitive

Although some recent writings about the Machine Tool Industry would lead you to believe that builders are all hurting from foreign competition and finding that the craftsmen across the ponds can make standard general-purpose machines for sale here for less money, such an impression is not valid for the whole industry. Isolationism is not the motto of the most.

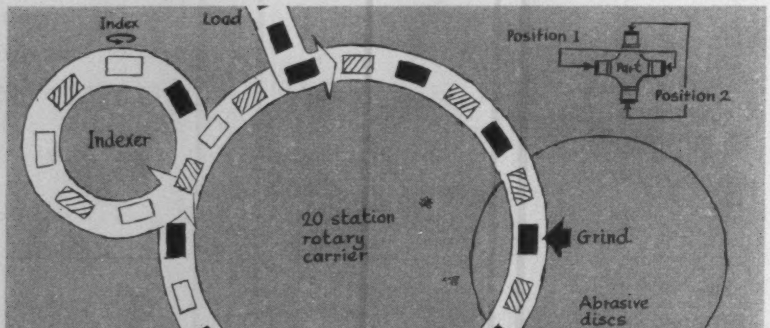
Many American firms have established business abroad. Some are tied-in with the foreigner (who has lower labor rates) and are importing general-purpose machines and selling them here. Most are selling special machines abroad. American technology is ahead in this area. Many are operating or building plants abroad to do business there.

It is reported that the European machine tool builders have such large backlogs that even orders for standard machines have spilled over to U. S. builders. The world market for machine tools may develop into being big enough for all. As builders learn to use automated techniques to make machine tools the difference in labor rates will have less effect on the competitive picture. As Europeans endeavor to satisfy expanding markets, their labor rates will rise and have a similar result.

Speculate

One other concept that puts many of the U. S. builders in a good position enabled them to see to it that the automaker not interested in NC did not go away from the exposition disappointed.

These particular builders have developed automated setups, engineered for the manufacture of a given product, and have thereby done the manufacturing engineering for their prospective customer. Machines that mill to length and center drill, turn crankshafts, grind them, special equipment to grind valves, and the like. Much of this is done without having an order for a machine.



Incoming universal joint spiders are automatically loaded into every other fixture on carrier of Gardner machine. Previously ground trunnion diameters of workpieces nest in vee blocks to achieve squareness requirement. Right angle diameters are located in equalizing U blocks to achieve centrality. Chain automatically clamps parts going into grinding area. Machine control sizing gage and automatic dressing feature keep discs properly spaced and true. After ends are ground in Position 1 parts are automatically transferred to indexer, turned 90 degrees, and transferred back to carrier so that every other fixture contains part to be ground in Position 2. Upon completion of both operations parts are automatically unloaded.

The builder sees that there is a need for equipment to make a product, studies the requirements, develops an automated machine, and offers it to all who make such products. As opposed to merely designing general-purpose machine tools this is speculation in the marketplace.

Yet such speculation is so closely associated with the needs of the prospective customers that there is reasonable assurance that many of them will take advantage of the new techniques developed for them. The teacher is not teaching cutting or grinding methods, instead he teaches manufacturing engineering. The automating automaker is more interested in learning how to make parts, than how to make chips.

A good example of this concept in practice was the Gardner Machine Co. exhibit. Of particular interest was the double horizontal spindle disc grinder engineered to fit into automated production lines for manufacturing universal joint spiders.

This machine automatically loads, clamps, grinds, repositions, clamps, and grinds again such that all four ends of the trunnion diameters are ground at the rate of 2400 parts per hour.

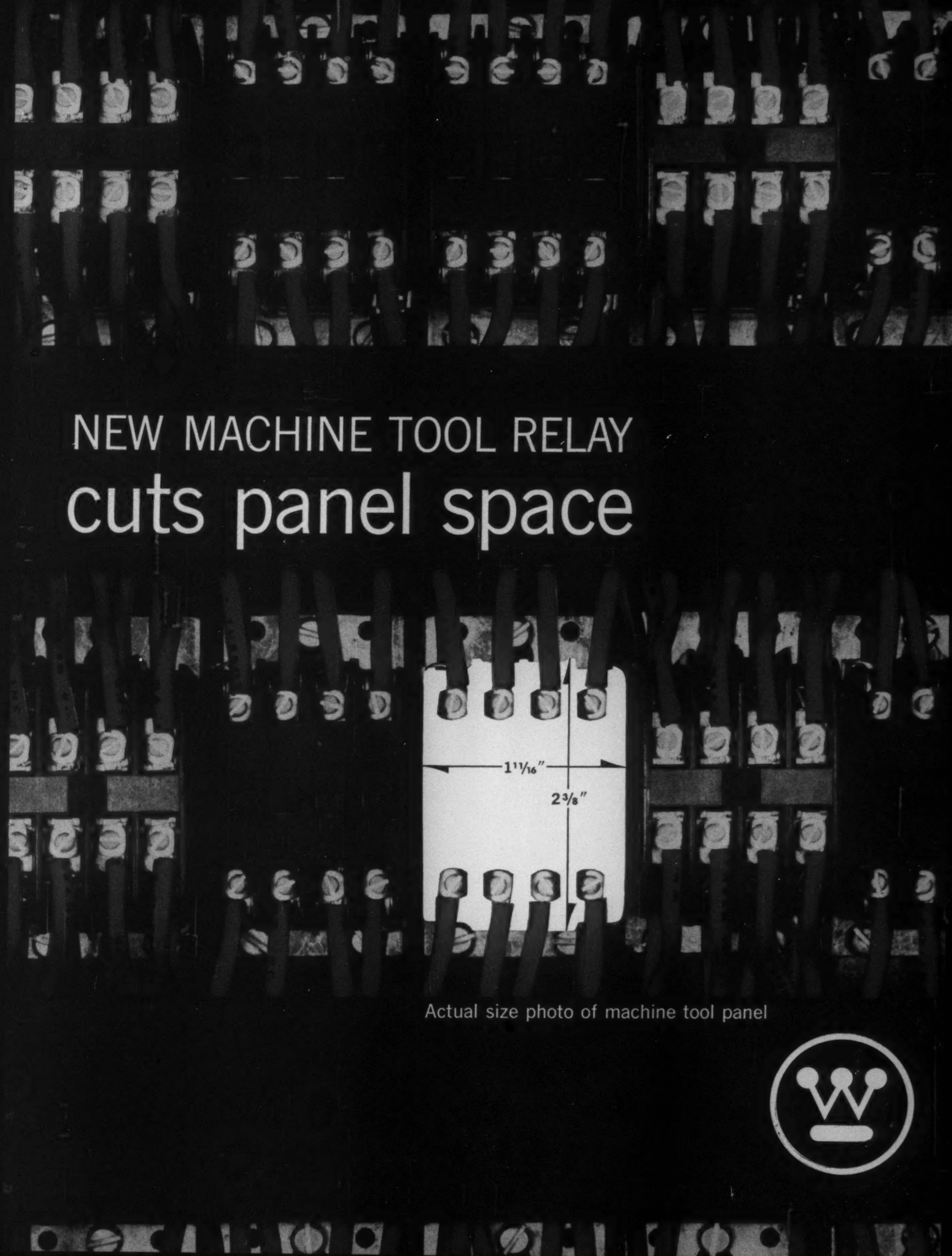
Such machine tools are in fact special-purpose machines designed by the builder to handle a class of products. Different customers may require fixturing of different sizes but the work cycle and machine elements will be the same for each customer having this processing problem to solve.

On machine tools of this nature the customer has very little special engineering to perform in order to incorporate the equipment into his production line. All three phases of the equipment design problem have been solved: 1. Work performing process. 2. Handling. 3. Control.

Machine tool builders who adopt this concept of equipment development are certain to enjoy a bigger share of the automation market than those who do not.

NEW MACHINE TOOL RELAY

cuts panel space



Actual size photo of machine tool panel

new machine tool relay cuts panel space 50%, reduces installed cost over 20%

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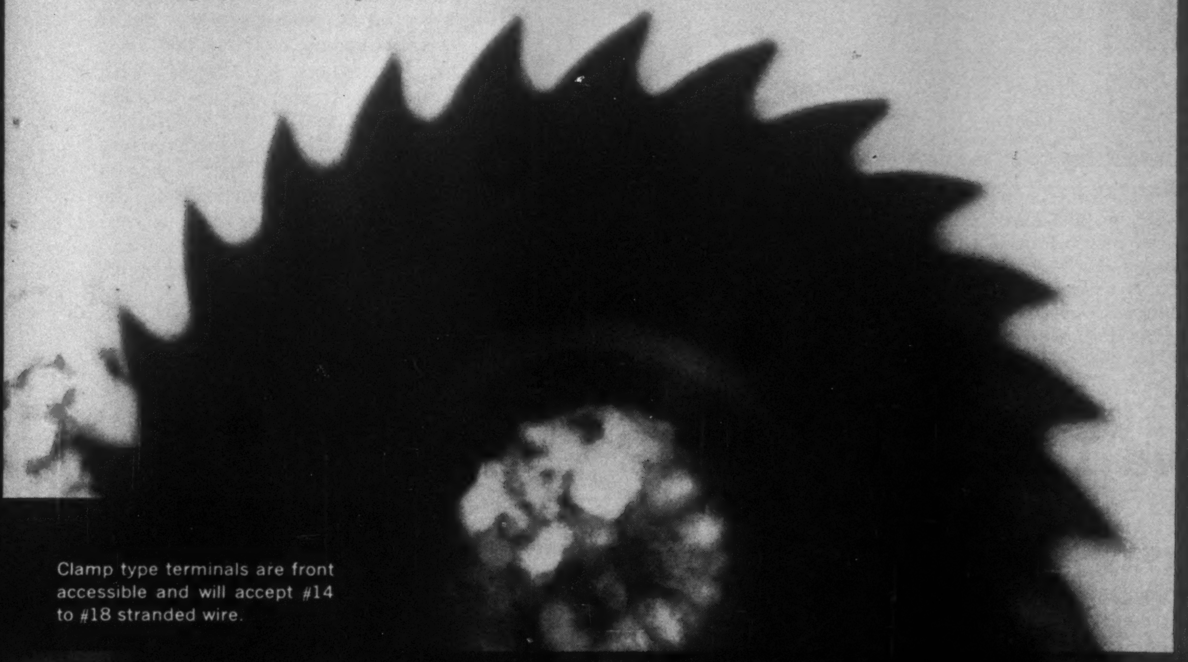
POLES
300
6
STYLE
SEE COIL FOR CONTROL VOLTAGE
MADE IN U.S.A.
WESTINGHOUSE ELECTRIC CORP.
ACTUAL SIZE

Westinghouse

Machine tool relay is rated 6 amps, 300 volts a-c, from 2 to 8 poles in 2 basic frames. Relays can be butted against each other to save space.

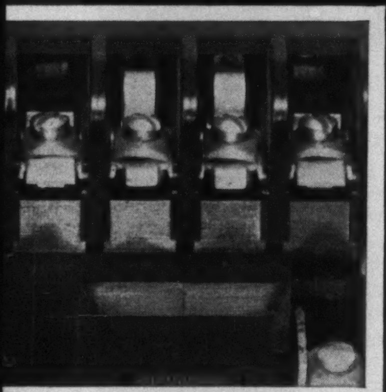
Here's the new Westinghouse relay that cuts the control panel space requirements as much as 50%. Specifically designed for use on automated machine tools, this relay is smaller than any other similar unit available. Relays can be butted against each other in banks. What's more, both 4 and 8 pole frames have the same mounting dimensions, occupy the same panel area, and can be mounted adjacent to each other without additional electrical clearances. ■ Wiring a panel is easier, too. Relay terminals are all readily front accessible. Each of these clamp type connections has a wire stop . . . installation is faster and costs less. You actually save more than 20% over outdated relays. ■ This new relay has load rating of 6 amps, 300 volts a-c—found by experience to be ideal for most of the machine tools now being designed. ■ Want more information? Contact your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. Remember: You can be sure if it's Westinghouse.

The Westinghouse BF relay is available from stock, now.



Clamp type terminals are front accessible and will accept #14 to #18 stranded wire.

J-30318



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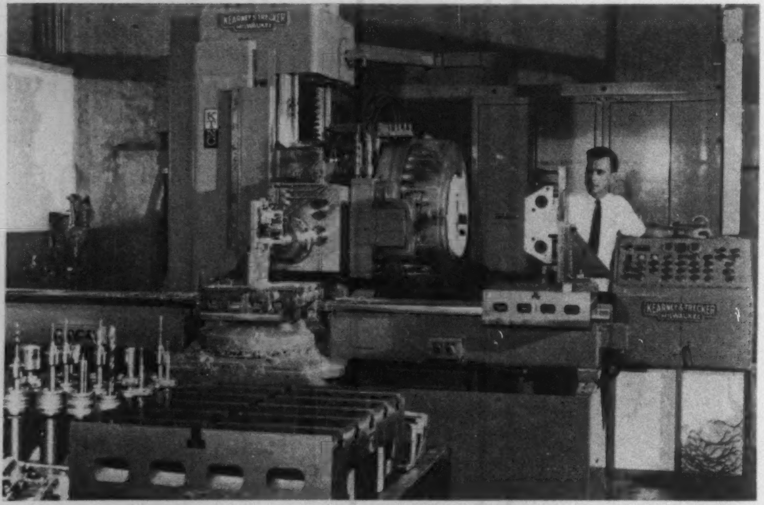
Westinghouse

western trends



A new numerically controlled production machining service is being offered to industry by Mill-A-Matic Machining Inc. of Santa Ana, Calif. This view shows the newly formed company's main machining asset—a Kearney & Trecker Milwaukee-Matic machine tool. Using the versatility of a single numerically controlled machine tool, the company plans to attract industrial customers who need service on small and medium-lot jobs that require a variety of machining operations.

Have Tool–Want Work

"HAVE Tool—Want Work" is an apt slogan that very easily could be used on the calling card of a new company recently formed in Santa Ana, Calif. In an action that could start another trend such as occurred with the development of the automatic screw machine, a group of entrepreneurs has seized upon the concept of using a numerically controlled machine as a basis for building a new machining service for industry. The key entrepreneur of this group is Vaughn Clark of Santa Ana who should receive credit for devising and implementing this "new frontier in metalworking."

It can be said that lightning first struck Clark in the Spring of 1959 when Kearney & Trecker Corp. first announced their tape controlled Milwaukee-Matic — a numerically controlled machine tool that can mill, drill, bore, ream, tap, and do other operations; automatically change cutting tools from a bank of 31 separate tools; and index an 8-position table to present more than one side of a workpiece to the working spindle. Column, saddle, and spindle head of the machine are power-fed to provide machining movements along three axes. A shuttle device permits automatic operation between two pallets which hold the workpieces and eliminate downtime for loading and unloading parts.

The Milwaukee-Matic contains all the elements of automation — automatic work performing, handling, and control—integrated into an in-line system. Clark was quick to latch onto the idea that here indeed was a complete job shop in one machine tool. Fifty years ago similar entrepreneurs saw the same elements of completeness in the automatic screw machine and used this machine to build an industry that offered job lot screw machining as a service to manufacturers. So it was that in June of 1959 Clark went to Milwaukee to discuss with Kearney & Trecker officials his plan of offering to industry a "numerically controlled production machining service." The idea was "enthusiastically seconded" by the manufacturer who promptly closed the deal by obtaining a signed and sealed order for a Milwaukee-Matic.

Implementing the Idea

Returning to California, Clark began to build an executive team to back up his machining "team." He chose men who not only had special training and background in all of the necessary areas of corporate operation, but those who also were willing to invest money to insure mutual interest in the success of the venture. This team includes Lloyd Maxwell, vice president; Bob Knutsen, secretary-treasurer; Gene Wallock, sales manager; and Pete Wanbaugh, production manager. Clark officially became president of the operation.

Since the whole concept of the new operation revolved around the Milwaukee-Matic, the name was probably dominant in the thinking when it came time to choose a name for the organization. The name selected was Mill-A-Matic Machining Inc.

The final touch of the real entrepreneur was in finding a home for the machine, the team, and the corporate name. No modest start

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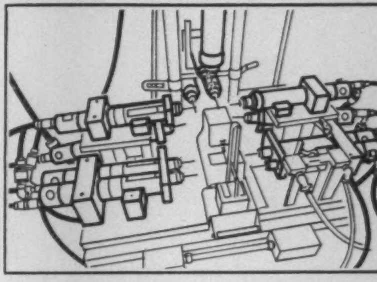

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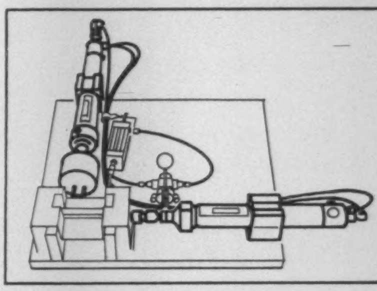
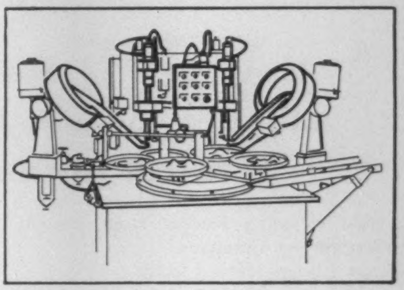
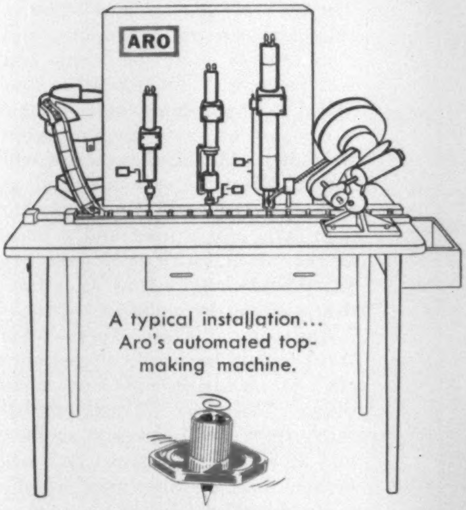


FASTEN 3,000 per hour

Go automatic on your threaded-fastener operations with Aro Self-Feed Screwdrivers-Nutsetters. Standard range of speeds for the most commonly specified screw sizes. Uniform torque settings held within close limits. All models available with precision ball-type clutch.





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Circle 689 on Page 19

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Circle 690 on Page 19

in a back alley shop for this operation! Ground was broken in December of 1959 for an 8000 sq ft ultra-modern building designed especially to house the Milwaukee-Matic. Anticipating a growth in the business, a foundation was provided for a second machine. A feature of the artistic beauty of the building is a tile mosaic which runs vertically beside the front entrance and represents a typical control tape used on the numerically controlled machine.

The building also houses a variety of conventional machine tools which are used to prepare work-holding fixtures and for tool maintenance. However, the prima donna of the entire operation is the Milwaukee-Matic, and the conventional tools can be considered as lackeys to serve its needs.

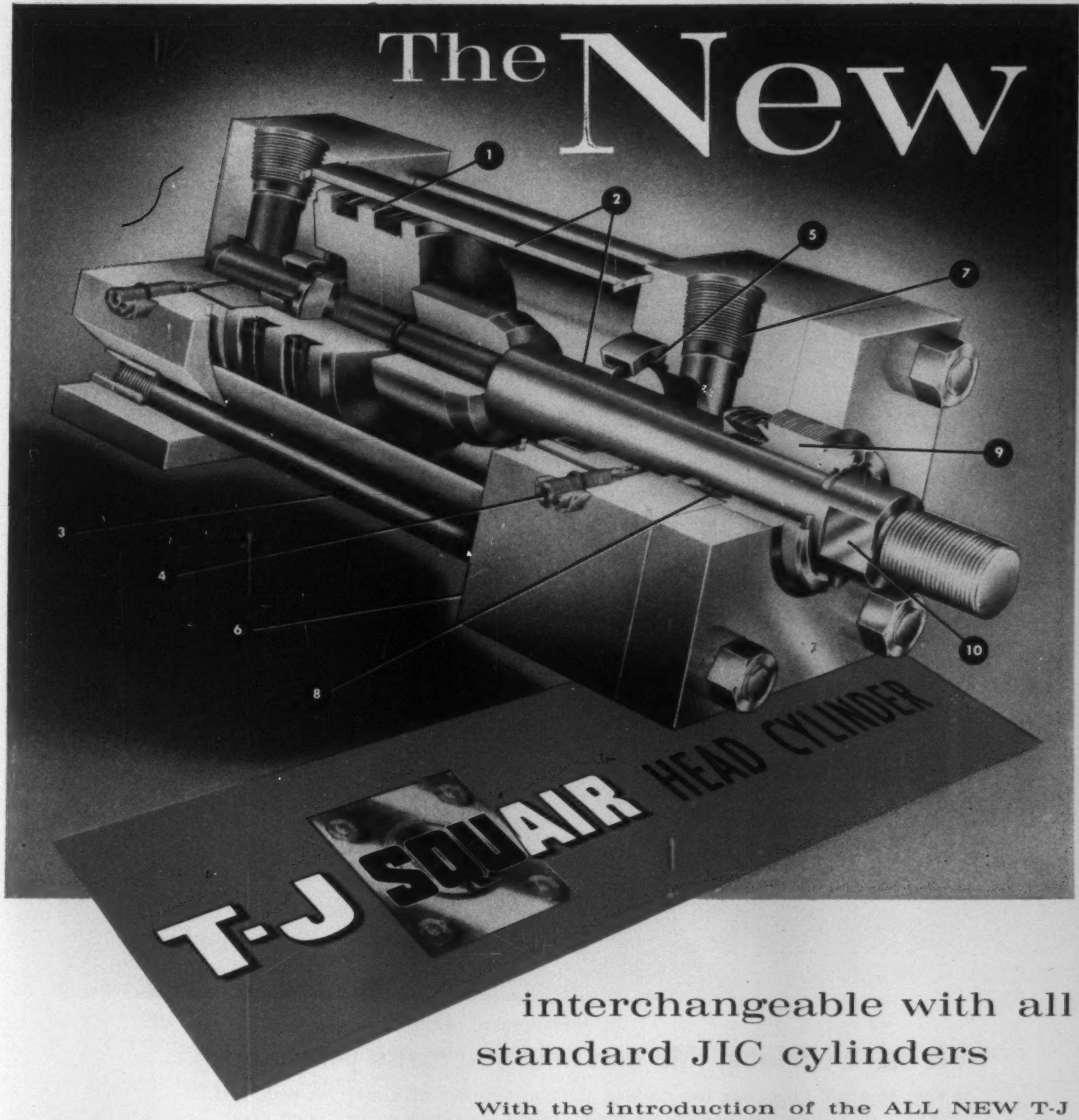
Under Clark's direction, Mill-A-Matic Machining Inc. has become an operating entity in just one year. Clark says it will offer a complete manufacturing service from engineering to finished products and will include assembly of parts, painting, packaging, and warehousing if these services are desired by the future customers.

Greater Ramifications

However, this shouldn't be the end of the story. Vaughn Clark has formed something more than just another machining service for industry. He has sparked an idea that could spread across the length and breadth of this country like wildfire. This idea could cause the formation of another new industry composed of people, a machine—numerically controlled of course, and a building to house the people and the machine. Numerically controlled machine shops could become as common as screw machine shops are today. Maybe these shops will not all be as well-planned and as well-organized as Mill-A-Matic, but there will exist a need and a place for them in industry as long as they can provide service and an attractive price tag for small-lot orders.

And so, "Have Tool—Want Work" could be a good slogan after all. It holds promise for many things. Only time will tell whether these things will develop as foretold or whether Vaughn Clark will become just another man with a great idea that didn't jell.

The New



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T-J

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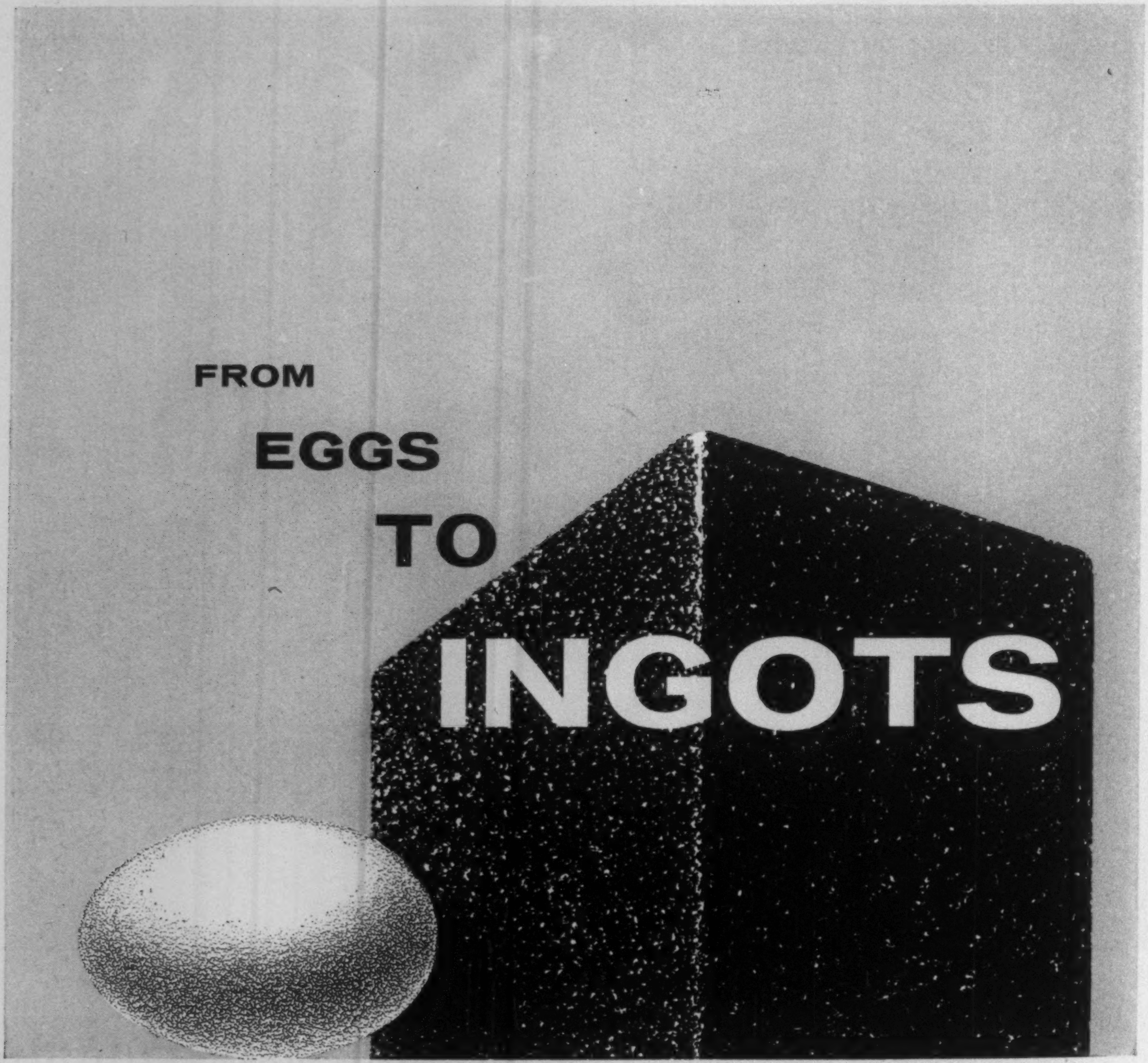

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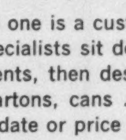


AUTOMATION

Risk

In the evolution of a successful business, perhaps the most notable factor involved is that of risk. Most businessmen recognize that significant industrial achievement often requires enterprising creative ventures based on carefully planned and calculated probabilities. Industry has long been accustomed to taking risks in the initial investment in the business, in terms of product development, and in terms of market development. No questions arise here concerning the validity of that old adage "nothing ventured, nothing gained." The risks are taken for granted.

Yet, there is an odd twist to the whole picture. When it comes to the development of processing equipment, industrial managers adopt a different stance. No risks, only guarantees. It seems that industrialists seldom associate the basic concept of entrepreneurial risk-taking with the development of new processes and new equipment to make the business more efficient.

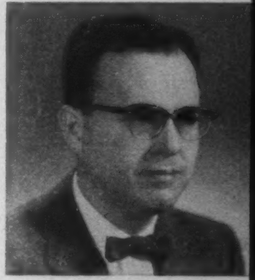
When we raise the questions, "Who pays for the engineering?" or "What are you doing about manufacturing research?", answers rather foreign to the entrepreneur seem to predominate. The situation unfortunately resolves itself into some moribund practices like depending on free engineering quotations for more efficient equipment, refusal to pay legitimate machinery development costs where they are obviously valuable, and waiting for someone else to carry out the research necessary to bring new production methods into being.

Risk-taking in the development of processing equipment is of key importance to any business. There is no alternative for a dynamic manufacturing research program encompassing both in-plant and outside equipment specialist efforts.

W. W. Kuyper, manager, manufacturing engineering, Large Steam Turbine-Generator Dept., General Electric, puts it in sharp relief with this observation, "There is a direct correlation between the success of any manufacturing business and the willingness of its managers to risk efforts and funds in the hope of making radical improvements in its own operations."

Are you investing for the future or just looking for a free lunch?

PUBLISHER-EDITOR



MANAGEMENT ASPECTS OF NUMERICAL CONTROL

By WILLIAM H. BENTLEY, Application Engineer, Cimtrol Div., Cincinnati Milling Machine Co., Cincinnati, Ohio

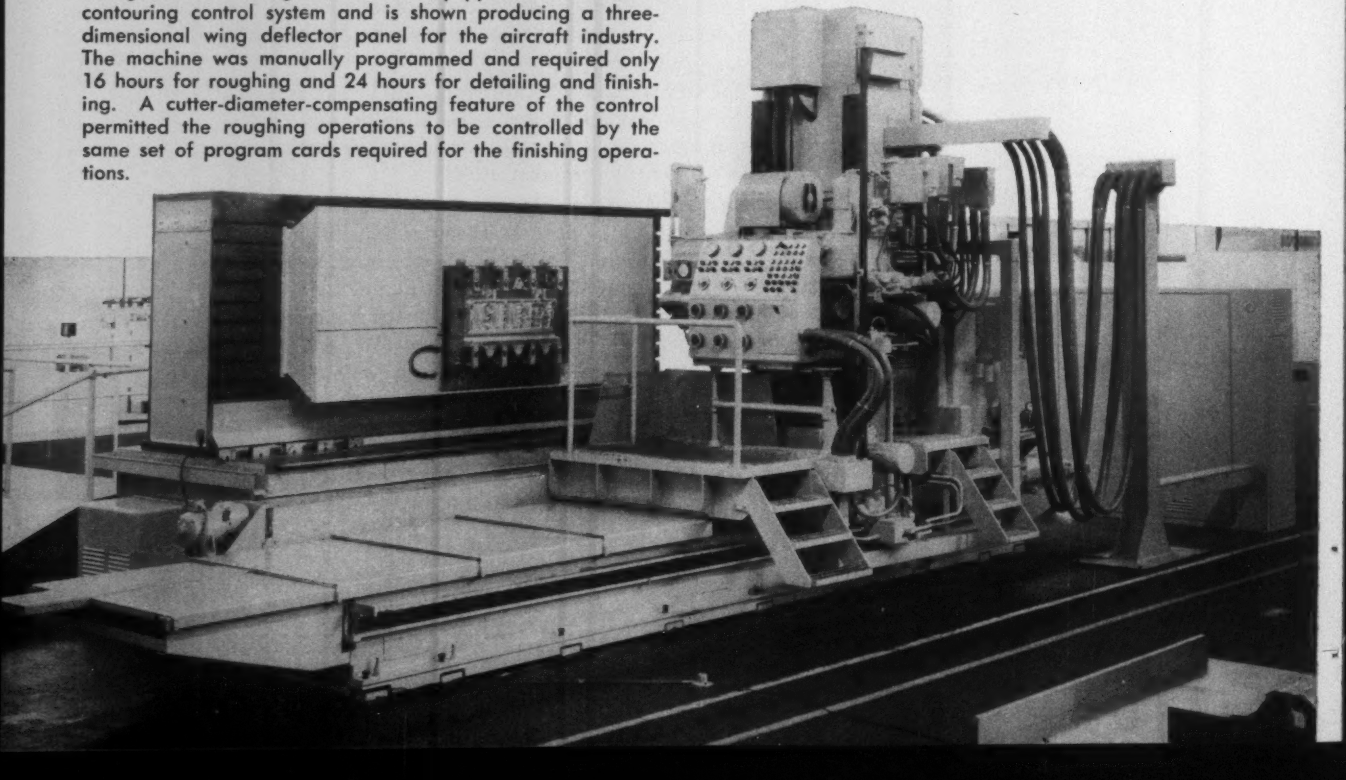
NUMERICAL CONTROL is not a machine control but a management control. To understand this viewpoint, the relationship of numerical control to the process phases common to all manufacturing must be examined. And this requires that the basic process phases be identified. What jobs must always be done when a product or an item is manufactured?

The first basic phase of the manufacturing process is *engineering.* This phase is the determination of the shape, size, tolerance, and material of the product. *Process planning* might be called the second phase of the manufacturing process. In this phase, the choice is made of the manufacturing device, or machine routing, the order of operations, tool design, jigs, fixtures, fittings, time study, operational analysis, quality control, inspection standards, and choice of feeds and speeds.

Another phase of the manufacturing process, which isn't as obvious as engineering and process planning, might be called *economic planning.* Included in this category are such topics as lot size decisions, i.e., the study of setup costs vs. unit costs vs. inventory costs, to determine how many products should be made at a given time to satisfy market demand. Finished goods inventory size is another point in this decision category. Raw materials inventory size decisions fit in with this also. Tooling inventory is another phase on which decisions must be made in the manufacturing process. All of these together may be lumped under one heading which we can call economic planning.

The final phase in the manufacturing operation is the *production* phase. Within this category are such operations as setup, machining, supervision, checking, and training of personnel. Often this last

With numerically controlled machine tools, complex shapes can be made at fairly reasonable costs. This Cincinnati traveling column milling machine is equipped with a 3-axis contouring control system and is shown producing a three-dimensional wing deflector panel for the aircraft industry. The machine was manually programmed and required only 16 hours for roughing and 24 hours for detailing and finishing. A cutter-diameter-compensating feature of the control permitted the roughing operations to be controlled by the same set of program cards required for the finishing operations.



That numerical control moves management closer to the production floor is a facet of numerical control that should be understood by all. Why is this important? As managerial sciences and techniques improve, it should follow that superior production capabilities will result to the extent that management can exercise the most effective control over direct production efforts.

phase of the manufacturing process is the only one a person thinks of as "manufacturing." However, all of the phases (engineering, process planning, economic planning, and production) are important to the manufacturing process, and the production phase is just one part of it.

In judging most new metalworking developments in the past, only the last phase has been considered. In judging numerically controlled tools, all phases must be considered. Why is this so? Because the production phase is becoming of less and less importance in relation to other phases. This is due to the advent of scientific management, large factories, and complex markets. Actual manufacturing of the product, or the production of the product, is becoming simple compared to the problems of engineering and economic planning. Certainly, trends in recent years showing the decrease in the number of blue collar workers relative to white color employees bears this point out. How then are the various phases affected by numerical control?

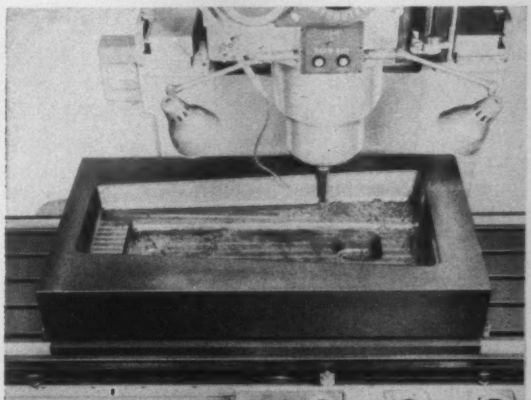
▶ Engineering

Starting with the engineering phase, it is evident that a good engineer should think in terms of economically producible shapes. A good engineer tries to avoid the tough shape. He has to be practical. Whatever he designs must be producible, and producible at reasonable costs. Numerical control opens the door for designs that are now considered to be economically unproducible. With numerically controlled tools, complex shapes can be made at fairly reasonable costs. Practically no operator skill is required. As a first observation, then, numerical control allows much greater engineering flexibility in shape design. Numerical control has one other very important effect in this phase: Numerically controlled tools are sufficiently flexible to allow improvements and design changes to be made with minimum expense. All of these engineering factors are concerned with shape, and it can be concluded that with numerical control the engineer commands the shape—his tools do not.

The particular facet of engineering concerned with part size is almost completely unaffected by numerical control. The controlling of a production machine by means of numerical data has almost nothing to do with the size of the part that can be manufactured. Size is associated with the machine tool alone. The actual maximum or minimum part size is determined by the geometry of the machine tool and is in no way determined by the control system.

One of the jobs of engineering is to determine the tolerances required for a specific part so that it can perform its function with the least possible cost. The task, as a general rule, centers around the fact that as tolerances become tighter, costs increase. The job of the engineer is to make the tolerances as loose as possible and have the parts still operate, or to design parts of such a character that tolerances are not critical. A great deal of engineering time, in the past, has been spent creating parts which could be very cheaply made without the requirement for tight tolerances. Our present day automobile is certainly an excellent example of this.

Numerical control changes this situation to a very great extent. With a given numerically controlled machine tool system, the tolerance is independent of the cost (up to the limit of the accuracy of the machine tool). If a given numerically controlled machine tool system has an accuracy of plus or minus 0.001 inch, there is no way to obtain any other figure, either greater or lesser. Therefore,



In conventional manufacturing operations, a large number of parts must be made during each production run to offset the costs of machine setup. With numerical control, lots can be run in small quantities to meet day to day requirements since setup time is negligible. For example, this large complex die for a motor compartment cover is being machined on a Cincinnati vertical milling machine using 3-axis contouring control. Notice the absence of complex fixtures and jigs since only simple hold-down clamps are required.

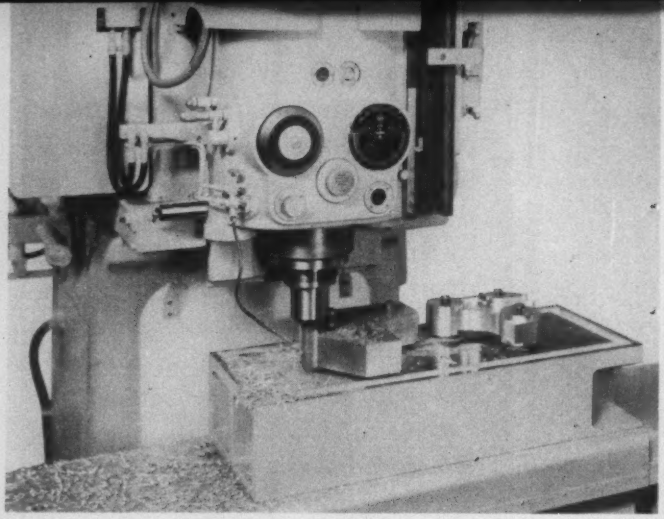
with numerically controlled tools it costs no more to specify the tightest producible tolerance than to specify a loose tolerance.

In regard to the specifying of materials by an engineer, this function is in no way related to numerical control. This is a property of the machine tool and not the control system. A machine tool is capable of cutting a certain material. Similarly, a numerically controlled machine tool cuts the same material—no better or no worse.

▶ Process Planning

An important part of process planning is machine routing, or determining the order of operations. These operations may be different with numerically controlled units because the machines are often different from conventional machines. But the job is basically the same, and it can be said that numerical control has practically no effect on this function.

Tool design is, however, a completely different story. Tooling is greatly reduced in cost by means of numerical control because such devices as complicated fixtures and drill jigs are essentially eliminated. The numerically controlled information to the machine tool provides position and repeatability without the need for an aid such as a drill jig or a milling fixture of a complicated nature. The only purpose of a fixture on numerically controlled tools is to provide an easy way to hold the part in position while it is being machined and to hold it in such a way that the cutter can perform all opera-



In a numerically controlled process, operator manipulation of a machine is greatly reduced. When every detail of a job is reduced to numerical data and placed on a tape or a card, the variable and judgment factors which require operator interpretation or skill are minimized. For example, these "mirror image" parts are being milled on a Cincinnati 3-axis contour controlled vertical milling machine. The part on the left is milled on one side, and then turned over and milled on the other side in the righthand station. All machine operations including the selection of feeds and speeds are controlled by punched cards. The operator's job is reduced to loading and unloading the part, inserting the proper tool in the machining head, placing the cards in the card reader, and starting the card reader.

A DIGITAL-ANALOG CONTROL SYSTEM

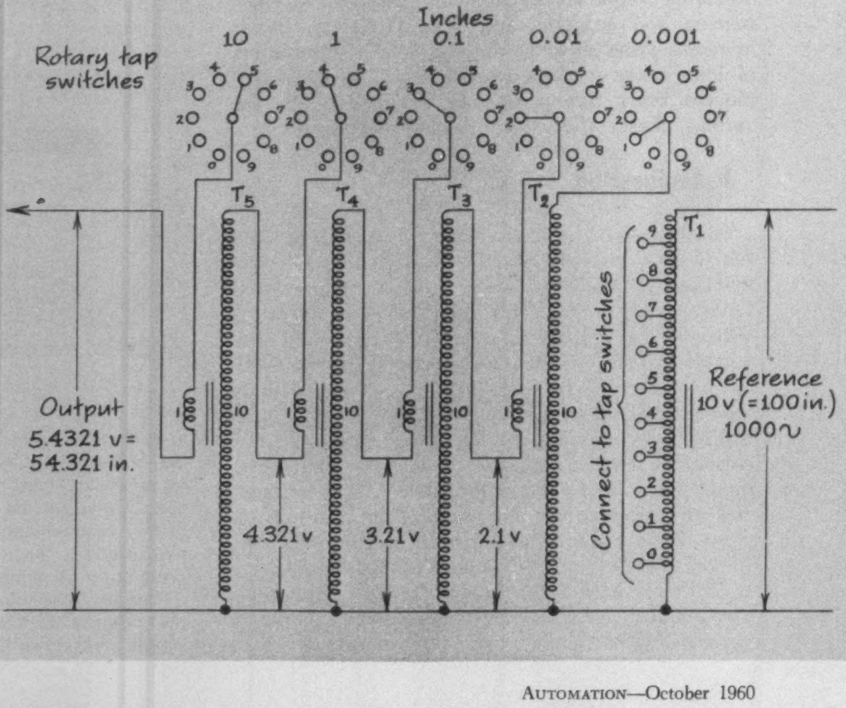


Fig. 1—Precise voltage divider uses one tapped toroid and four adding transformers. Rotary tap switches connect to toroid transfer at taps which divide 10-volt reference signal into ten equal parts. With switches as indicated, successive stages of adding and stepping down voltages results in output signal of 5.4321 volts. With a reference signal of 10 volts representing 100 inches, output voltage represents 54.321 inches.

tions. Usually, the simplest form of clamping fixtures are adequate.

So far as the time study and operator method analysis phases are concerned, numerical control has a very great affect on these functions. Numerical control eliminates most of time study in its conventional form of a man studying a machine operator with a stop watch in his hand. But it definitely does not eliminate the function. The programmer now determines the times and methods. In the programming operation, the programmer fixes methods and times by means of numerical data. He directs the machine tool as to how it is to complete a machining operation. This direction is locked in. There can be no variations from job to job. And there can be no deviation from the time estimate made.

The job cost is determined at the programming point in the process, and it is fixed from there on out. This fact, however, can be a double edged sword. On the pro side, it means that the manufacturer not only manages men but also manages machines. On the negative side, it gives the manufacturer the opportunity to mismanage machines. Under the conventional machining process, it is often left to the discretion of the operators and the production supervision to do a competent job and, under various incentive systems or no incentive system at all, to do a job in a fair length of time. When every detail of the job is reduced to numerical data, this discretionary factor is completely eliminated. If the job is programmed in a clumsy and slow fashion, the job will be perpetually done in a clumsy and slow fashion as long as the program is used. On the other hand, if the programming function is accomplished through sound principles, then the best talents can be brought to bear on making the production operation most efficient and most economical.

The quality control aspect of the process planning phase is very much like the job of engineering specified tolerances. That is, it is to a large extent predetermined in the numerically controlled process. To process planning, however, this has an additional significance. Quality control inspection, particularly of the in-process variety, is no longer needed to any great extent. There is the chance that tools can get dull or that other wear may develop. This phenomenon, though, is no different than that occurring with other automatic forms of machinery. The important fact is that quality control inspection is not required to assure management the operators are meeting engineering specifications.

This review of the process planning phase shows that it is almost inseparable from the programming function of numerical control. And this is truly a major step forward in the manufacturing operation. No longer are the planning functions transmitted to supervisors, routers, operators, and inspectors on the operational floor in terms of descriptions, words, and other English language communications. This information is now carried directly to the machine tool in the form of numbers. The discretionary area has been essentially eliminated. These jobs are now fixed and predetermined. There is almost no area

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THROUGH its Cimtrol Div., the Cincinnati Milling Machine Co. manufactures a full line of numerical controls and related forms of programming controls for a variety of equipment. Controls have been applied to such diverse machines as milling machines, drilling machines, lathes, precision boring machines, tube-flaring machines, and index drilling machines.

The term "Acramatic" is used to identify the line of numerical controls. Either eight-level punched tape or business-type punched cards (Remington Rand) can be used to store input commands in digital form. Within the control system, this digital information is converted into analog form, expanded by an interpolating section, and compared to analog signals generated by a feedback transducer—thus obtaining an error signal that actuates the equipment drive (typically an electrohydraulic servo valve). The control systems are "absolute" in that all numbers representing dimensions are given relative to a common zero or reference point.

Turning to contouring control for an example of the systems offered, perhaps the first feature that stands out as being unique is the possibility of using punched cards at the machine tool for data input into the control system. Punched cards permit a large quantity of information to be introduced simultaneously into the system. The use of punched cards is an outgrowth of the type of programmed information that the control system can accept.

The purpose of any programming operation for contouring machine tool applications is to establish exact input data that describe what a machine is to do in order that a workpiece of desired form and dimension can be obtained with a given cutting tool. A certain complexity is inherent in contour machining because typically it is at the edge of the cutting tool and not at its center line that metal removal takes place. If the desired motion of the center line of a cutting tool be considered a "path," it is possible to describe the path as consisting of a combination of straight and curved lines. For straight-line cuts, the edge of the cutting tool can be directed by only a few commands along a desired path and a straight cut obtained that is limited only by the accuracy of the machine tool-control system. Curved line cuts can be more of a problem in that literally thousands of commands might be required to direct the tool along the exact curve representing a contour. However, machining tolerances permit some freedom in establishing the actual path taken by a cutting tool in that the curve can be approximated by various techniques, such as by a series of straight lines (chords) or by a series of arcs (circular, parabolic, etc.). The approximation technique, then, determines to what degree the general problem is simplified in so far as programming is concerned. And to the extent that the problem is simplified, the requirement for computing aids in programming is reduced.

In programming an Acramatic control, in general, the desired machine tool path is described geometrically as a series of "spans," each straight line span consisting of two sets of co-ordinates (beginning and end points of a line) and each curved span consisting of three sets of co-ordinates (beginning, mid, and end points of a line). Adjacent spans share a common co-ordinate point. It should be appreciated that successive spans can represent paths of various lengths left for misinterpretation or individual interpretation that may affect the predictability, the cost, the quality, and the time to perform a manufacturing operation.

▶ Economic Planning

One of the first jobs in the economic planning phase is to determine lot sizes. Numerically controlled production has two beneficial effects in the area of lot-size control. The first is that numerical control reduces setup costs. This reduction in setup costs not only saves the amount of money that would have been spent on setup, but it also reduces the size of the most economic lot. Under conventional manufacturing operations where setup costs are relatively high, it becomes economical to make a large number of parts once the money for the setups has been spent. With numerical control, lots can be run in small quantities, meeting the requirements from day to day.

The second benefit of numerical control in regard to lot sizes is that numerical control provides accurate process costs and an accurate and predictable way to calculate setup costs, since the setups are so simple and straightforward. With this feature of high process predictability, it is possible for management to calculate accurately what the most economical lot size would be. Under conventional manufacturing operations, the calculation of the economic lot size is somewhat nebulous. It is impossible to know to a high degree of precision the exact unit cost of every part, and it is very difficult to tell exactly what it is going to cost in terms of an operator's time and the time of a machine which is not producing parts. With numerical control, setup time is reduced to such a small amount that, even if a great error is made in estimating it, in terms of dollars an error is not particularly significant.

In relation to the finished goods inventory size, numerical control is very advantageous from the standpoint of economic planning. Not only do the lot size reductions, made possible through numerical control, help reduce finished inventory size, but the fact that setups can be made on very short notice enables finished goods inventories to be reduced even further. The short lead time required to put a numerically controlled machine into production enables replacement stocks to be kept at very low levels. At any time, replacements can be manufactured on short notice and in small lots to meet demand. One way to look at this is that the inventory of machine control tapes or cards really replaces the actual parts inventory. Once a part manufacturing description has been reduced to numerical data by means of the programming operation, the tape or punched cards can then be kept in storage as a form of inventory. On very short notice, this data inventory can be transferred into physical parts. Inventory is replaced with production flexibility and speed.

The raw materials inventories cannot be reduced as much as the in-process and finished goods inventories. The reason for this is that to obtain the

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(to a maximum of approximately 35 inches each). For this reason an interpolator time interval for the travel of the tool along the line represented by the span must be determined in order to maintain the desired speed of travel of the tool relative to the workpiece.

With the several co-ordinates of a curved path and a time element established by the input data, the control element performs a basic interpolating function, successfully directing the cutter over a parabolic path that passes through the desired points defining the workpiece contour. Using this technique, whereby the control itself generates a parabolic path from only a few co-ordinate points, when the desired tool path can be described by a relatively small number of spans, the necessary computations in programming can be made conveniently on a desk calculator. For more complex operations requiring a large number of spans to describe a cutter path, the programming data are more conveniently calculated with the aid of a general purpose computer.

Both input signals and feedback signals are obtained by nonelectronic means, utilizing precision toroidal transformers, variable linear transformers, sine-cosine resolvers, stepping switches, and similar electrical components. For an input signal, voltages are synthesized as analogs of the co-ordinate data punched into the input media. For each axis of motion, these co-ordinate voltage analogs are synthesized in five memory units within the control. Five memory units are required to provide for a smooth flow of input signals concerning a given axis, three of the units being used at any given time with the remaining two being loaded with new co-ordinate data from the input source.

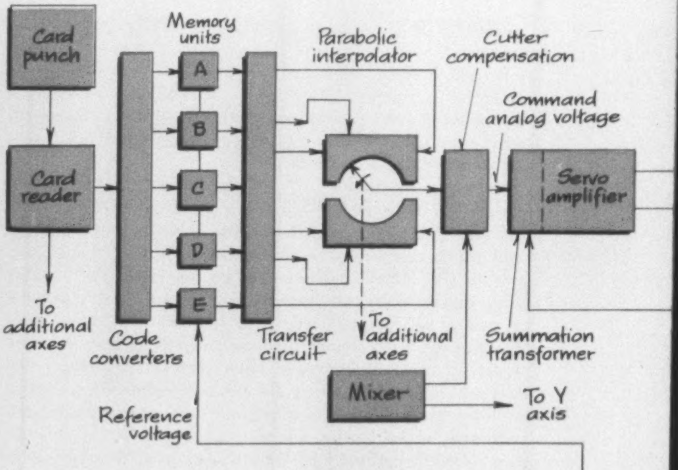


Fig. 2—Diagram (for one axis) includes representations of several features of numerical control system. Analog signal output of parabolic interpolator can be offset by cutter compensation unit to permit use of tools differing in size from that for which the taped program was prepared. Telephase link allows major portion of control to be placed in control cabinet away from machine; "zero shift synchros" permit the reference point specified by a program to be shifted by the operator at the machine to agree with actual location of work.

greatest advantage with numerical control the user should be able to set up small lots on very short notice. This requires having the raw materials on hand. In the past, this was not too much of a problem because it took a sufficiently long time to put a manufactured item into production, and there was plenty of time to order the material. With numerical control, the waiting time to get raw materials can become the controlling factor in the whole process. Without good control over raw materials stock levels, the time and predictability advantages of the numerically controlled process can be lost.

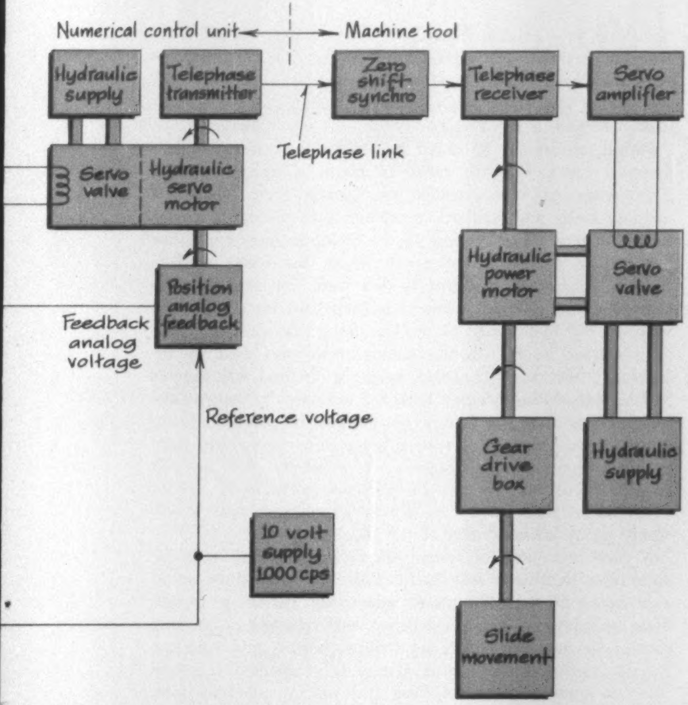
Economic planners are also interested in the control of tooling inventory. The direct replacement of many jigs and fixtures through the use of a numerically controlled process is quite obvious. It should also be noted that numerical control can effectively be used to reduce the manufacturing cost of necessary jigs and fixtures. This may seem to be contradictory in that the requirements for jigs and fixtures are vastly reduced by numerical control. However, there are situations in some plants in which only a few numerical controlled tools exist and many standard tools are present. It might be more advantageous to put the numerical control tools to work producing the fixtures for the standard tools rather than use the numerical tools for production. The numerical controlled tools are particularly adaptable to complicated, precise jobs which are made in small lot sizes, perhaps even lots of one. In fact, the more complex or precise the job, the lower the lot size that will justify numerical control.

▶ Production

In looking at this phase of the process, the first factor to be considered is the operator of the machine. The initial job that confronts an operator is to interpret drawings. Using numerical control, this interpreting job is essentially eliminated. The interpretation has already been done at the programming stage long before the raw materials or the tape have reached the production floor.

So far as "operator manipulation of the machine" is concerned, it is obvious that it is greatly reduced with numerical control. The function of the numerically controlled input is to manipulate the machine from the standpoint of dimensions and, frequently, from the standpoint of feeds, speeds, and other auxiliary functions such as coolant control. The number of variables and judgment factors are greatly reduced by numerical control. These judgment factors are never eliminated—they are merely placed at the earlier stage of programming. At the programming stage, if managed properly, these judgment factors can be dealt with in a uniform and efficient manner using the principles of scientific management, rather than depending upon the judgment of each individual machine operator.

With a numerically controlled process, the supervisor is principally concerned with work flow. He is very little concerned with the technique type of supervision. With conventional machines, the supervisor is constantly checking machining practices,



A single memory unit includes a precise reference voltage source in the form of a tapped toroidal transformer. By means of the taps, the reference voltage is divided into 10 equal parts. If, for example, input co-ordinate data consist of a five digit number (54.321 inches), five rotary tap switches would be provided, one for each digit in the number. By the technique illustrated in *Fig.* 1, the tap switches connect several adding transformers to the reference voltage source (10 volts = 100 inches), with the output of the memory unit being a synthesized analog value (5.4321 volts) of the five digit co-ordinate number (54.321 inches). A given analog signal is available to the system until a new co-ordinate point is introduced into the particular memory unit.

It will be recalled that three memory units are in use at any given time. These units would contain, for example, the three co-ordinate points that define a curved span. However, contouring control requires that the tool be controlled continuously between these three points. It is the function of the interpolator part of the control system and associated circuits to generate the smoothly varying voltage signal for continuous control. Here again, circuits are composed of such components as toroidal transformers, rotary switches, and induction potentiometers. The general technique is to introduce the co-ordinate voltage analog signals into a tapped transformer circuit. In accordance with the interpolating speed punched into the input medium, a rotary switch steps across the transformer taps to obtain the more numerous signals necessary for continuous control.

In generating a continuously varying signal representing a straight line, the interpolating circuit divides the difference the general operation, and the drawing interpretation technique of each of the workmen who are his subordinates; he might be called the number one craftsman.

In a numerically controlled process, supervision can do very little to alter or check the way the machine is operating when it is receiving instructions from a piece of tape. The supervisor's principal job then becomes one of work-flow expediting. The supervisor must be sure that he has the tapes, the raw material inventory, and the right type of setup in order to produce the work with his machines. Thus, he is more a manager of machines than a manager of men. As a result, he can usually supervise more production. For example, instead of exercising supervision over four to seven men operating conventional machine tools, he can perhaps supervise ten or twelve men who are attending numerically controlled machine tools because the nature of his job is not detailed supervision but keeping track of and controlling over-all work flow. This can be done for many more workers using numerical control than it could possibly be done under conventional production techniques.

The checking and training functions of supervision are also essentially eliminated through the use of numerical control. Undoubtedly, there is something for the operator to learn in operating a numerically controlled machine tool. But this learning is not of the craftsman or conventional machine operator type. The principal skills of the operator of a numerically controlled machine tool are simple setup skills and work transfer skills. This means that instead of the conventional learning curve associated with the standard machining processes, a very short learning curve should prevail. That is to say, a new operator or an operator working on new parts can come up to maximum speed and efficiency very rapidly because he has limited judgment jurisdiction over the process.

Tooling room type machine tools imply the fact that the operator has a good knowledge of setup and extensive setup skills. Conventional automatic machinery, such as automatic screw machine, requires a very high setup skill on the part of the setup man. These setup skills are expensive and sometimes very difficult to find at the right time. The setup operation in numerical control, or what may be called the counterpart of the setup operation is really done by the programmer, not on the production floor but in an engineering or manufacturing office. Consequently, in relation to the actual production operations, the setup skills for numerical control are less than those of any other manufacturing process.

In summary, then, the impact of the numerically controlled machining process upon engineering process planning, economic planning, and production—the four basic phases of the manufacturing process—leads to the conclusion that with numerical control we have management control. Now we can be certain that what management has determined to be *correct* for costs, machining times, feeds, speeds, tolerances, etc., *will be carried out.*

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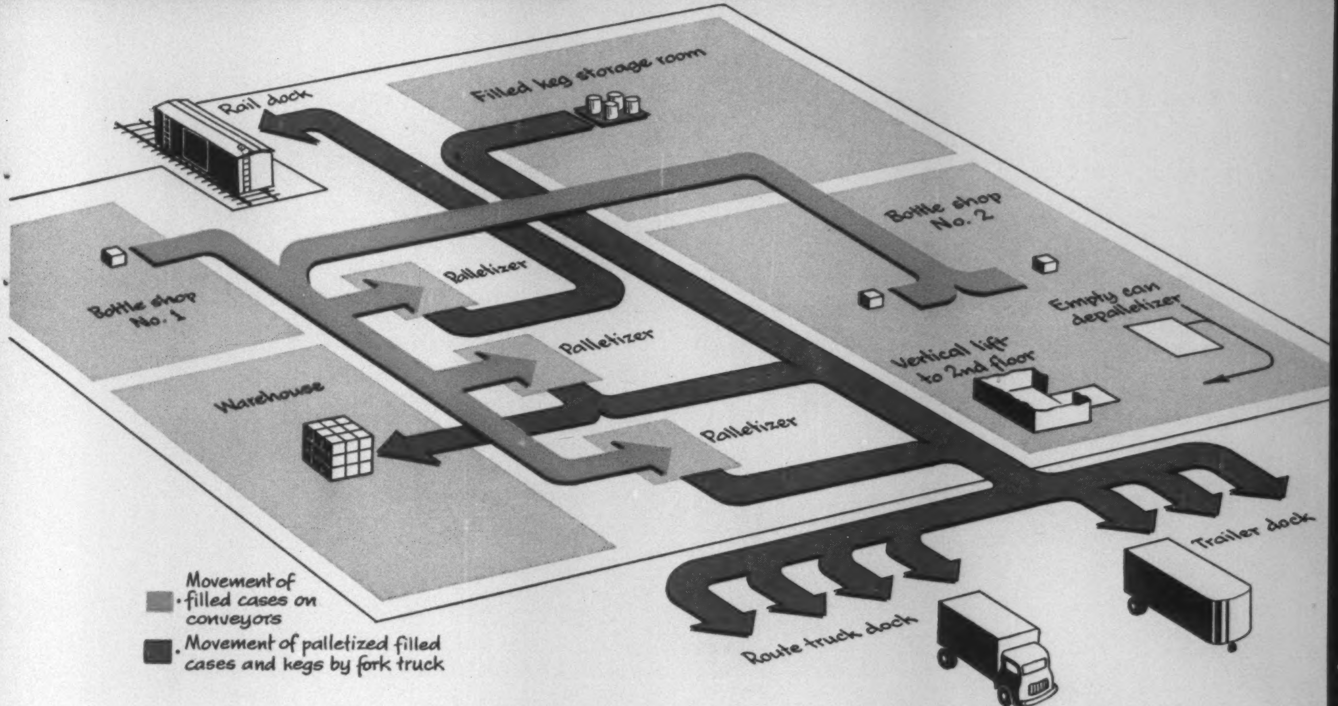
between two co-ordinate analog voltages (representing beginning and end points of the line) into an equal number of voltage levels. To generate a parabola passing through three co-ordinate analog voltages (representing beginning, mid, and end points of a curved line), essentially what would have been a straight-line interpolation is modified by the mid point co-ordinate analog voltage through an additional transformer. As a result, instead of the interpolated voltages between end-points of the span being in equal steps resulting in a straight line, the voltages for the interpolation points are compensated by voltage increments varying progressively in such a pattern that a parabolic arc is formed.

The output, then, of the interpolator is a smoothly varying voltage signal that is an analog of the desired position of the cutting tool. This command analog voltage is fed into a summation transformer where it is compared with the feedback analog voltage that represents the actual position of the cutting tool. The feedback analog voltage is generated as a ratio of the same 10 volt reference voltage signal that is applied to the memory units. This, and the fact that dimensions are expressed as voltage ratios, eliminates possible errors due to voltage fluctuations. The technique for generating the feedback analog voltage is comparable to those previously referred to—with the typical problem being that of obtaining a precise voltage analog that varies linearly with a leadscrew rotation. The desired voltage analog is obtained by a combination of three components—induction potentiometers, fine rotary switch, and coarse rotary switch—and associated tapped transformers. The outputs of the several voltage sources are combined by a stepless switching technique to eliminate the discrete steps which might otherwise be obtained. The error signal, in the form of a voltage ratio that results from a comparison of the command voltage analog and the feedback voltage analog, is then amplified to actuate a servo valve.

Perhaps it should be noted here that the basic system is designed for a 100-inch range of travel along major axes. This range can be extended by incorporating additional memory units and feedback components to provide a coarse analog system. The purpose of the coarse system is to move the cutting tool into the range where the basic, or fine control, system can perform as described. For example, this type of analog control system has been used on a skin mill with an 800-inch range of motion along one axis.

As shown in *Fig.* 2, the analog techniques used in the control system permit certain types of manual adjustments to be made at the machine tool. For example, by varying the interpolating rate, the rate of cutting can be adjusted. Compensation can be made for tools whose diameters differ from that for which a given program was prepared. Still another adjustment allows the zero or reference point to be shifted in so far as the controls are concerned to agree with a reference point actually used at the machine tool.

A contouring control system employing punched cards for data input has been described. This is one of three available types of control systems employing variations of the basic techniques. One of the other two types is a positioning control for such operations as drilling, boring, and reaming. A rate controlled positioning system is available for certain types of turning jobs and fixed bed milling machine jobs.


Rail dock
Filled keg storage room
Bottle shop No. 2
Palletizer
Palletizer
Palletizer
Bottle shop No. 1
Empty can depalletizer
Vertical lift to 2nd floor
Warehouse
Trailer dock
Route truck dock
Movement of filled cases on conveyors
Movement of palletized filled cases and kegs by fork truck

1

Schematic plan view of first floor at Lone Star Brewing Co. plant illustrates major flow paths for filled cases of beer to palletizers, and for palletized loads to trucks, trailers, or railroad cars. Kegs on pallets may also be routed to trucks and trailers, and some pallet loads of filled and empty cases may be stored in warehouse areas. Return pallet loads of empty bottles are delivered to second floor by means of vertical lifts. Incoming pallet loads of empty cans are depalletized in unit shown and fed in single lines to can fillers.

AUTOMATION TODAY

INTEGRATING CASE HANDLING

By **ARMAND T. GAUDREAU**, Consultant, Gaudreau Associates, Weston, Conn.

MILLIONS of beer cans and bottles are handled annually at the Lone Star Brewing Co., San Antonio, Tex. In a recent modernization program engineered by Gaudreau Associates, these handling functions were mechanized through adoption of equipment such as conveyors, lifts, palletizers, and depalletizers. Necessary plant alterations to accommodate the new equipment, improve the flow of products, and utilize storage space more efficiently were also supervised by the latter firm.

It was largely the standardization and synchronization of the operations of receiving empty cans and bottles in bulk or reshipper cartons, and of shipping them out filled with beer and packed in cases, that paved the way for mechanized handling. These operations were integrated into a plantwide handling system which greatly improved the efficiency of the brewery.

Handling of bottled beer represents a two-way movement consisting of the return shipment of empty bottles in cases and the outbound shipment of full bottles, also in cases. Although canned beer does not involve a return shipment of empties, it also represents a two-way movement in the receipt of empty cans and the shipment of full cans in cases. For both types of beer containers, therefore, there

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Incoming pallet load of cases of empty bottles is shown being placed on conveyor apron of vertical lift. When lift has discharged its load to powered accumulating conveyor on second floor, and returned, the load on the apron will be moved onto lift, raised, and discharged automatically. Two lifts of the type shown, built by Alvey Conveyor Mfg. Co., are used in the plant.

is an inbound movement of empties and an outbound flow of fulls.

Cases of returned empty bottles are received, for the most part, in palletized loads on highway trailers, rail cars, and city route trucks. Cases received hand-stacked on carrier decks are transferred onto pallets inside the carriers before being unloaded, so that they also can be handled by fork truck beyond that point. Pallet loads of empties returned to the brewery range from 5 to 7 layers in height depending upon the inside height of the trailer body. When received in boxcars, the loads are usually 8 layers high.

When a highway trailer has been spotted at the dock and made ready for unloading, a fork truck is driven inside the trailer body, picks up a pallet load of empties, and deposits the load on the intake

Pallets containing cases of empty bottles are accumulated on conveyor, right, before entering depalletizer, left, in front of column. Loads may be removed from accumulating line by fork trucks and stored when necessary. If incoming flow of palletized cases from floor below is inadequate to keep depalletizer operating at full capacity, loads may be added to line from storage.

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conveyor apron of a vertical lift at the dock end of the bottle shop. Two automatic conveyor lifts are provided to elevate the pallet loads of empty bottles to the second floor of the bottle shop.

Upon reaching the second floor, the vertical lifts automatically discharge each pallet load onto a powered accumulating conveyor. The lifts can be programmed to follow definite patterns of operation. For example, they can elevate a load of empties or fulls to the second floor, discharge their load, and return empty to the first floor. Or, they can elevate a load of empties and return with a load of fulls from second-floor storage.

Successive loads of empties on the accumulating conveyor are fed automatically to a case depalletizer which removes and stacks the pallet and discharges the cases in a single line. From the depalletizer, the cases of empty bottles are dispatched to any of three overhead conveyors leading to the bottle shops on the first floor. By means of pushbuttons, the depalletizer operator directs the flow of depalletized cases from one conveyor to another depending on which one is running out of cases.

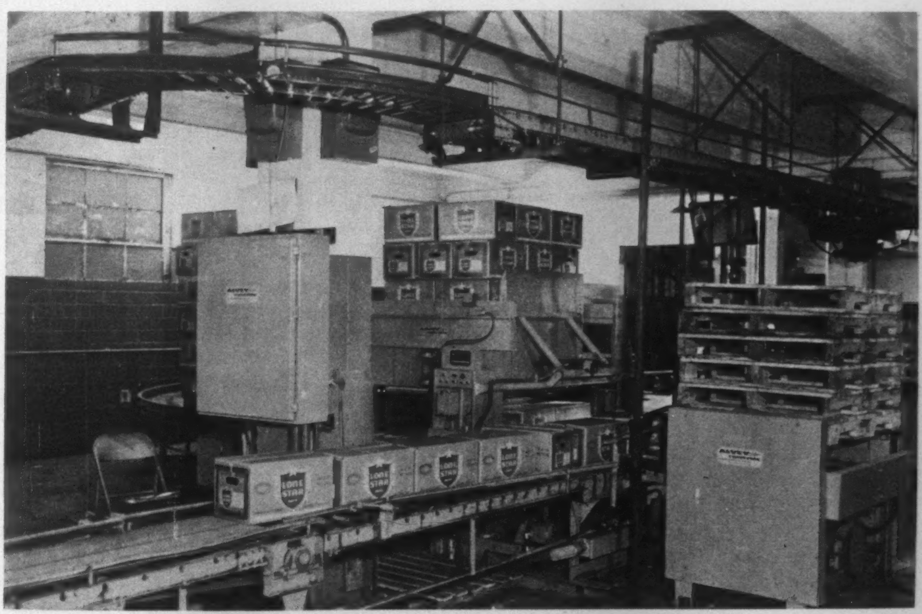
Before entering an automatic uncasing unit of a bottle soaker, the empty bottles in each case are inspected for defects. The uncaser then automatically unloads the bottles and places them on an accumulating table at the input end of the soaker.

The empty cases are conveyed to carton cleaning operations and then to packing machines at the end of each bottle production line. When the cases have been loaded with full bottles of beer coming off the lines, they are moved to a battery of three case palletizers and stacked on pallets.

Handling of incoming and stored empty beer cans has always posed a problem because of the nature of these containers. Past practice has been to pack the empty cans in reshipper cartons at the can factory, and to hand-stack these cartons inside boxcars or highway trailers for shipment to the brewery.

At the brewery, a network of portable conveyor sections was set up to connect with powered conveyor runs which led to can uncasing and unscrambling machines. The emptied reshipper shells then had to be carried by conveyor to can packers. Use of reshipper cartons of incoming empty cans necessitated permanent crews of throw-on and throw-off men along the conveyor lines, particularly when the cans had to be stored before being fed into production.

A method of dispensing with reshipper cartons,



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Close-up of discharge end of Alvey Conveyor Mfg. Co. depalletizer shows cases emerging from unit in single file and with uniform orientation. When pallet load is positioned in depalletizer, both load and pallet are raised by a lift table. A pair of side clamping arms, background, then closes on load so that pallet may be lowered on table and transferred to stack at right. In subsequent machine cycles, the bottom layer of cases is lowered and transferred to conveyor until stack is exhausted. As each layer of cases is discharged onto the conveyor, a case-pivoting device makes the cases all head lengthwise. Belt conveyor, left foreground, transfers depalletized cases to any of three overhead lines for movement to bottle soakers on first floor. There, empty bottles are inspected for defects while still in their cases and then enter automatic uncasing units at the bottle soakers.

case conveyor lines, manual case handling, can uncasing machines, and can unscramblers was developed by the local can factory of the American Can Co. Now the cans arrive in pallet loads tiered two-high on trailers. Each load is held together by a corrugated overwrap.

Pallet loads of cans are removed from trailers by pushing them on roller conveyors. Inside the building, a fork truck detiers the pallet loads and places them, one at a time, on the feed apron conveyor of a can depalletizer. The wrapper is removed from each load, and the load is squared, before it enters the depalletizer.

This machine is operated by one man, and feeds a supply of empty cans to a cable conveyor that leads directly to a can filler. Capacity of the filler is 600 cans per minute. The operator of the can depalletizer is the only other worker, in addition to the fork truck operator, needed to complete the flow of cans from incoming trailers to can fillers.

Filled cases of bottles and cans are counted mechanically before leaving the packers and entering a shipping department conveying system. The filled cases travel on the conveyors over various paths such as around 90-degree turns, up and down interfloor inclines, through wall openings, and above machinery and equipment. Automatic traffic controls, photoelectric cells, solenoid-controlled pressure

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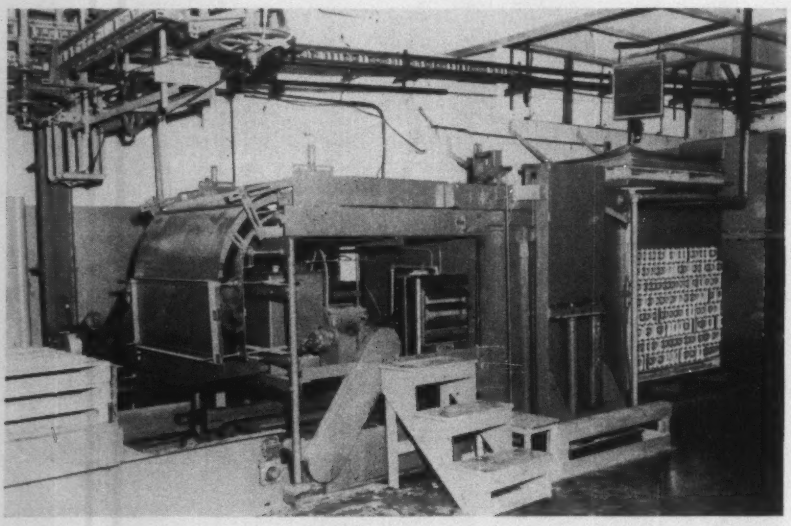
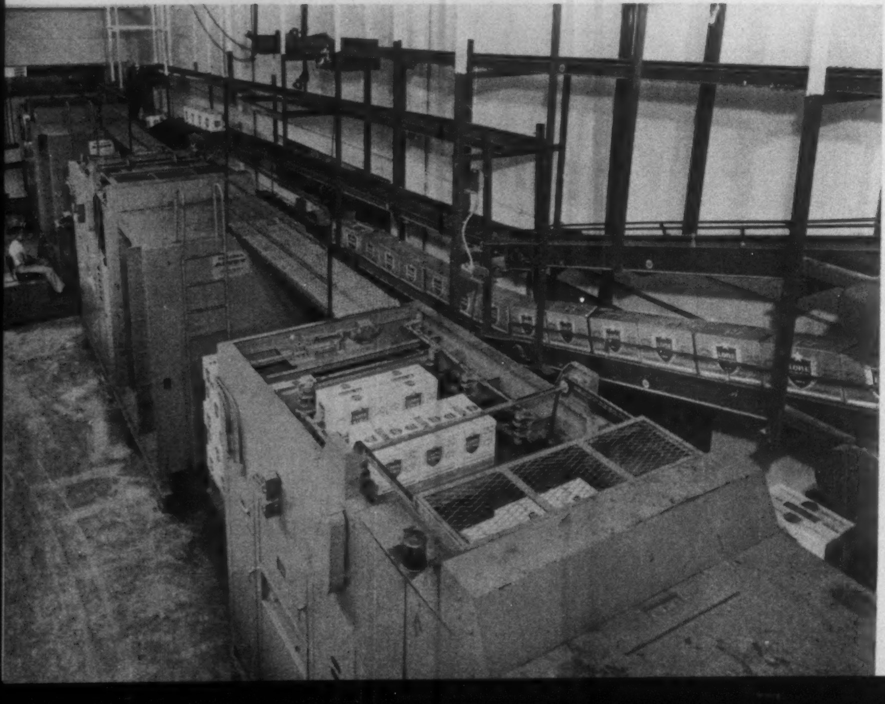
Pallet loads of empty cans, with corrugated overwraps to hold them together, are removed directly from trucks on roller conveyors, right. Each load is unwrapped, squared, and fed to depalletizer shown. Unit, developed by American Can Co., moves each pallet into position by means of powered chain conveyor, lifts the pallet and load, and successively sweeps each top layer of cans off its chipboard spacer onto horizontal mesh belt above wooden steps. Cans then enter curved chute at left end of machine and cascade into horizontal position, one row above another. From bottom of chute, cans are fed in a continuous line into vertical cable conveyor and then to overhead conveyor leading to can filling machines.





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Cases of filled cans or bottles may be routed from overhead feeder conveyors to any of three Alvey Conveyor Mfg. Co. palletizers shown. Before reaching feeder conveyors, production lines of like products have been merged. In palletizing, cases enter top side of each unit and are formed into layers. A pallet, fed from a magazine, is then elevated to receive first layer. As this layer is deposited on pallet, the pallet is lowered to receive the next layer. When the correct number of layers has been accumulated, pallet load is discharged onto apron at end of machine. Fork truck is shown in position to pick up a pallet load from center palletizer.

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Last step in process is loading of carriers with pallet loads of filled containers. Fork truck is shown placing pallet load of cases in trailer. Loads at right represent overflow from production lines at case palletizers.

stops, and hinged-belt conveyors control the flow of cases to the three palletizers.

All three of the palletizers can be fed from any of the can and bottle case conveyor lines. When the same product is arriving on two or more production lines, these runs are merged before reaching the conveyors feeding the palletizers.

After palletization at the machines, the pallet loads of cases that are scheduled for immediate shipment are picked up by fork truck and transported directly to outbound carriers. Palletized stock taken out of storage, and palletized beer kegs, are likewise trucked to outbound carriers.

Pallet loads not destined for immediate shipment are trucked individually from palletizer discharge conveyors to either a case warehouse near one of the bottle shops or to one of the two automatic vertical lifts for storage on the second floor.

In setting up the case-handling modernization plan at the brewery, the run-through principle was made a primary objective wherever it could be developed and applied in the handling of both empties and fulls. This called for adjustment and reconciliation in the timing of production runs of specific case goods to coincide with the time and quantity of the loading of these products in boxcars, reefers, and trailers. Keeping bottle and can lines running directly into outbound carriers, without having to resort to storage areas for absorbing over-runs or supplying shortages, except for impending holidays, became the keynote in synchronizing the planning of production and shipments.

Distributors now send in their orders for an entire week a few days in advance of a given week. These orders are immediately summarized for each shipping day by products and by individual carload and truckload. Using these shipping requirements as a basis, plus whatever stock may be on hand, a daily production schedule is set up for each working day in the following week.

To carry out these shipping schedules and avoid flooring the output, a dispatch office is maintained at a central point near the palletizing machines. The daily shipping schedule, broken down by carriers and by products for each carrier, is revised each morning to make adjustments for deviations made from the previous day's schedule.

A running inventory is kept of each product from day to day which tells the dispatcher at all times exactly how many cases of any product are on hand in the morning, how many are being produced and shipped on that day, and what the closing balance will be at the end of the day. He has this information for the entire variety of products throughout each of the two shifts that the plant is operating.

Thus, by a co-ordinated, plantwide system of handling empties and fulls, prescheduling, and using automatic handling machinery and equipment wherever possible, the brewery has integrated its handling operations into an efficiently functioning system.

STAFF of Automation regretfully records the death of *Armand T. Gaudreau*, author of this article. Mr. Gaudreau was known throughout industry for his consulting work in materials handling and as co-author, with Randolph W. Mallick, of the book "Plant Layout" published by John Wiley & Sons Inc. For a number of years he and Mr. Mallick organized and taught courses in materials handling and plant layout at the University of Pittsburgh.

Prior to forming his own firm, Gaudreau Associates, he was a member of the firm of Gaudreau, Rimbach & Associates. Previous to that time, he was employed by the Barrett Div. of Allied Chemical Corp., Westinghouse Electric Corp., and later was connected with the consulting firm of Stevenson, Jordan & Harrison.

Throughout his career, Mr. Gaudreau was active in technical societies, belonging to American Society of Mechanical Engineers, American Material Handling Society, and American Statistical Association.

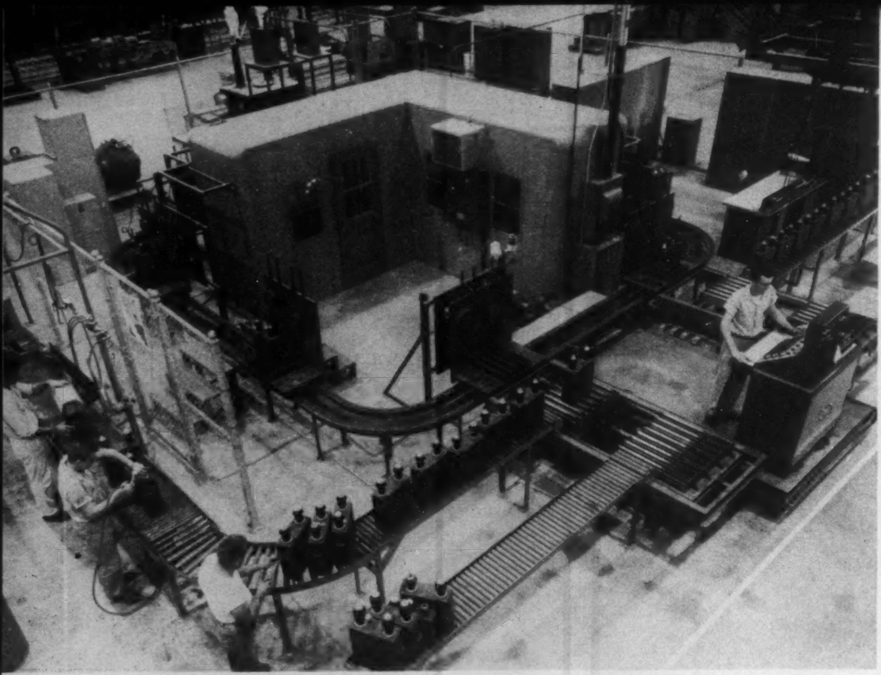


Fig. 1—General view of an automatic capacitor testing facility which uses an Opcon optimizing controller to operate a capacitance bridge. Capacitors enter the facility on the conveyor at the upper right. They are transferred onto dollies on the closed loop testing conveyor by means of a pneumatically operated loading table. The dollies carry the capacitors in a counterclockwise direction around the testing loop until the unload station, center of picture, is reached. At this point an unloading table picks up a capacitor and transfers it either to the final packing conveyor, where the three men are working, or to the defective unit conveyor in the right foreground.

APPLYING AUTOMATIC OPTIMIZING CONTROL

TO PRODUCTION LINE TESTING

By **E. L. MALLICK**, Superintendent of Operations, Distribution Apparatus Dept., Westinghouse Electric Corp., Bloomington, Ind.

THE PROBLEM in optimizing control is to bring a process to optimum conditions—maximum output, maximum profit, or minimum cost—by regulating the input variables and by determining the effect of the regulation on the process through the sensing and feedback of output information to the control. Once an optimum process condition has been attained, the optimizing control should maintain this condition regardless of changes in the input variables.

Specifically, an optimizing control is a device for controlling a system or a chemical or manufacturing process by optimizing some measurable characteristic of its output. Such a control operates by making input changes, sensing the resultant changes in output, and feeding this information back into the system so as to arrive ultimately at optimum operating conditions. The purpose of such a control is usually to provide adaptability to changes in external conditions which may be uncontrollable, unmeasurable, or unknown.

Attempts in the past to develop an optimizing control have been stifled by an adherence to commonly accepted approaches to control problems. These include such techniques as the one-variable-at-a-time approach, the feeling that continuous sensing is necessary, a tendency to try to solve a completely nonlinear problem by starting with linear approximations, and a general attempt at greater sophistication in making use of all obtainable information.

In developing its system of optimizing control called Opcon, engineers and scientists at Westinghouse Electric Corp. used an approach which differs from previous thinking about adaptive controls in the following basic features.

1. The control is based on employing a definitely multivariable type of strategy. The one-variable-at-a-time method of experimentation, which is still all too common in engineering techniques, has been abandoned. Therefore, the

system can exercise intelligent control over many variables at the same time.

2. The control employs a selective memory. This is an aspect borrowed from human behavior, although the undesirable random component of human retentiveness has been eliminated. A tendency in the past has been to think in terms of a control which remembers everything that has happened. However, it is clear that in many applications stored information quickly becomes obsolete and trying to retain it merely produces unnecessary complication and expense.

3. The control is selective in its use of even the newest information. Some approaches to the optimizing problem have stressed linear approximations which have been adjusted to compensate for nonlinearity. Unfortunately, optimizing is not an approximately linear problem. It is the nonlinearity that is the most essential part, both from the point of view of maximizing and from the use of feedback of information. The strategy of the Opcon optimizing control is based on two objectives—to learn and to make progress to an optimum. The learning process is included only to hasten the objective of progress. Therefore, the control strategies are designed to do only as much learning as seems necessary to attain the immediate objective.

4. The control's optimizing procedure is discrete, allowing it to handle problems where sensing of output can only take place at intervals of time. This does not prevent efficient functioning in cases where the output can virtually be measured continuously. The use of high-speed components allows a discrete system to handle such cases.

▶ Control Application

Opcon had its earliest application in a device to balance an ac bridge network as part of an automatic capacitor testing facility, *Fig.* 1, at the company's distribution apparatus plant in Bloomington, Ind. The completely transistorized control secures a capacitance determination in less than five seconds.

An operator of a process can manually obtain optimum operation by experimentally changing input variables, by noting the effect of such changes on the process output, and then by making additional changes based on the success or failure of previous trials. Such a method of experimentally reaching optimum process conditions can also be accomplished automatically with a system described by the author and documented with an operating application example.

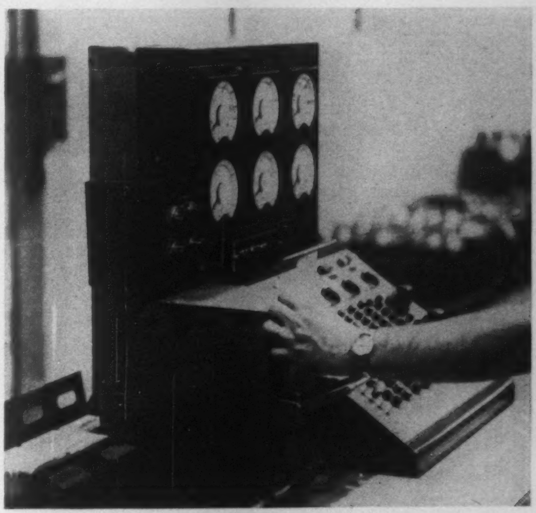


Fig. 2—The capacitor testing facility is co-ordinated by a central control which stores the information needed for test control, sequences and times the test cycle, collects the test results, compares them with acceptable limits, and indicates *Pass* or *Fail* and the details of a failure. In this view an operator has selected the proper punched card for a capacitor under test from the file on the left and is inserting the card into the card reader.

The capacitor testing facility was designed as part of a single automated production line. Production runs of thousands of a single style of capacitor, or many styles of smaller quantity, mixed in any way, had to go through the test facility.

In developing the test line, the following objectives were established as guides:

1. To provide repeatable test cycles with conditions accurately controlled so as to minimize the tests' contribution to apparent product variability.

2. To detect and discriminate test failures automatically.

3. To minimize manual handling, both of materials and of data.

4. To permit random intermixture of capacitor styles and thus eliminate the need for a storage area in which to segregate the output of the production line.

Capacitors arrive on a roller conveyor, from which a loading table transfers them to dollies on a carrousel-type conveyor. These dollies carry the capacitors through the testing facility and contain lug contacts which pass between wire brush contacts to complete electrical circuits at the test stations.

After each capacitor has been loaded, an operator connects electrical test cables by hand. He then selects a punched card bearing the capacitor's style number from a file at the control console and inserts the card into the system's card reader, *Fig.* 2. This card carries in punched form all the informa-

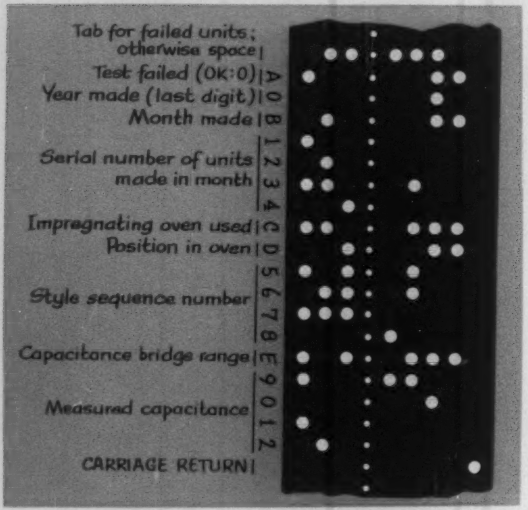


Fig. 3—When a capacitor has received all its tests, the results are assembled and punched into a paper tape in the format shown. With this record, the test results can be tabulated for inspection or converted to punched cards for more detailed analysis.

tion required to test the capacitor. Upper and lower capacitance limits, test voltage levels, and resistance limits plus some identification numbers are read from the card into memory when the conveyor carries the unit into the first test station.

In order to permit completely random intermixture of capacitor styles, it is necessary to have available different sets of information for the various test stations as different style capacitors proceed around the conveyor. This requirement is satisfied by reading all the data applicable to a given capacitor into a memory unit from which it is transferred step by step as the capacitor to which it refers moves from station to station. In this way, the information is read only once as the capacitor enters the first test station, and the card reader is then immediately available for the next, possibly different, program card.

Each capacitor is subjected to five separate test operations. In the first test, capacitance is measured and compared to the high and low limits punched into the card. This provides partial insurance that the capacitor and card are properly matched, and also provides the necessary quality check on actual capacitance. Capacitors can range in value from 0.02 to 2000 farad, and in this test a resolution of 0.1 per cent and an accuracy of 1 per cent of the indicated value must be measured before the unit can be tested at the remaining stations.

The capacitor then moves to the second station where the insulation between active elements and their case is checked with a high voltage ac ground test. Depending upon the size of the capacitor, voltages ranging up to 80 kilovolts at 60 cycles per second are applied for 60 seconds. At the next test position, the dielectric strength of the capacitor is tested by subjecting it to a large terminal-to-terminal overpotential. Capacitors rated over 2300 volts are charged to a high dc voltage which is held for 10 seconds and then shorted to produce a high current surge. Any marginal electrical connections are detected since they are automatically destroyed. Capacitors under 2300 volts are tested with a high ac voltage at 25 cps.

After the capacitor has been stressed with the preceding tests, its capacitance is measured again and compared with the original measured value. A difference of more than 1 per cent indicates that the unit has failed under stress. Although most failures are detected when they occur during the stress tests, the capacitance test provides a double check of the various fault-detection devices. The last test made on a capacitor is a terminal-to-terminal measurement of dc resistance. Many capacitors are made with internal bleeder resistors to reduce any remaining charge to harmless levels after the unit has been de-energized. This test verifies the actual presence of the bleeder resistors and ensures that they are operating properly.

As the capacitor moves to successive test stations, the memory provides the control data required at each station and collects the test results. These test results and some identification are punched out in paper tape, *Fig.* 3. With this machine language record, the results can be tabulated for inspection or converted to cards for more elaborate statistical treatment.

▶ Optimizing Control

Most of the test stations consist of simple, straightforward sequencing and timing systems and are all controlled by Cypak static controls except for an ac bridge network. The balancer for the capacitance bridge is unusual and operated by an Opcon optimizing control.

In the ac bridge network, two inputs interact in their effect on one output. The output (bridge error voltage) can be measured with considerable precision, so that small changes can be observed. The optimum condition is well defined being a zero error voltage. The characteristic of this process which defeats attempts at a simple servo solution is wide variation in correlation between changes in one input, and the phase angle, relative to the bridge excitation, of the resulting change in output voltage.

The complete automatic capacitance tester is made up of three basic sections as shown in *Fig.* 4. The three sections are as follows:

1. An ac bridge network with balance controls arranged to be varied by the control section.
2. A control section which decides what changes in the bridge balance controls are appropriate in view of the information received from a success/failure discriminator.
3. A success/failure discriminator which examines the bridge output voltage to determine whether or not the latest adjustment produced a better balance than the most recent successful adjustment.

A Wien bridge network was chosen for this measurement. It is unusual only in having variable elements switched in steps rather than continuously adjustable. On account of their reliability and low contact resistance, mercury-wetted relays, driven by transistors in the control, are used to switch resistors in the variable bridge arms.

The control is a transistorized signal director that might be called a computer in the sense that it performs functions for handling numerical information. Its role is to decide the size and direction of the change to be applied to either an adjustment as a result of the success or a failure of the previous changes. This strategy is built into the control and cannot be changed without rewiring.

In addition to a control system to carry out the strategy, Opcon applications require some means of indicating to the control whether or not each change in its turn produces an improvement in the output. The system must base its decisions on the last successful trial. Thus, to be considered a success, a change must have produced a result better than any other result produced up to that point. A device to indicate success or failure must therefore be capable of storing the actual result of a successful trial through all succeeding failures until another successful trial is made.

These requirements are satisfied by first converting the bridge output voltage to a time interval by comparing it with a ramp waveform. This time interval is then stored as the space between two pulses on a delay line. In order to avoid difficulties in timing the comparison waveform, the leading pulse of the interval initiates operation of the entire control. Amplitude-to-time conversion on each trial begins as the leading pulse from the preceding trial emerges from the delay line. Success or failure is then determined by whether or not the bridge output voltage matches the value of the ascending waveform before the second pulse arrives. If it does, a success is signalled, and this point becomes the new second pulse for future trials. If not, the old second pulse remains as a reference, and a failure is reported to the logic section. The timing of the delay line produces a new trial about every 235 milliseconds. Total time for a measurement is therefore about five seconds for the twenty trials necessary to secure balance from the most adverse starting conditions.

This control approach can be advantageous when much is known of the process controlled as well as in the more general case that supposes very little information available. When much is known of the controlled process, enhanced stability and freedom from elaborate auxiliary control features are probably less important than the chance to use inherently more reliable components.

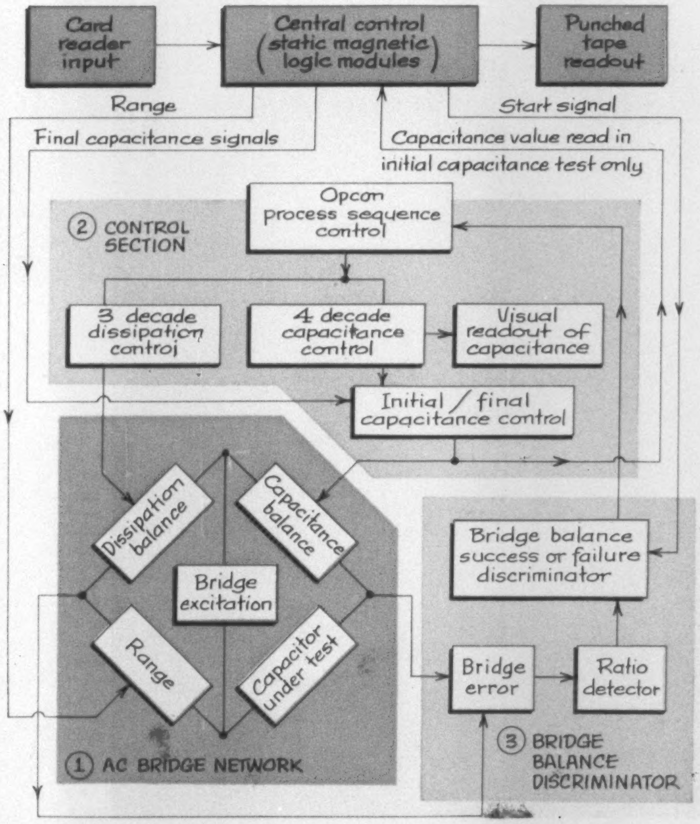

Card reader input
Central control (static magnetic logic modules)
Punched tape readout
Range
Start signal
Final capacitance signals
Capacitance value read in initial capacitance test only
② CONTROL SECTION
Opcon process sequence control
3 decade dissipation control
4 decade capacitance control
Visual readout of capacitance
Initial / final capacitance control
Dissipation balance
Capacitance balance
Bridge excitation
Range
Capacitor under test
① AC BRIDGE NETWORK
Bridge balance success or failure discriminator
Bridge error
Ratio detector
③ BRIDGE BALANCE DISCRIMINATOR

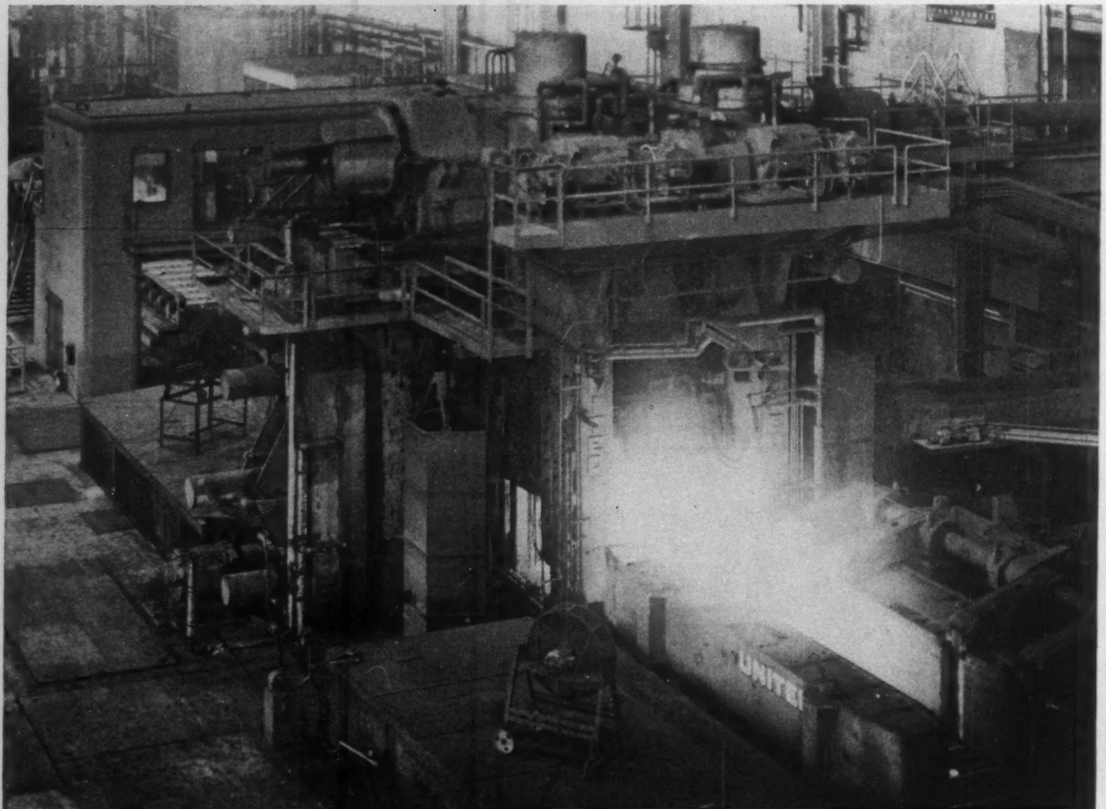
Fig. 4—Block diagram illustrates the operation of the Opcon optimizing control in balancing the capacitance bridge. The three sections of the capacitance tester are the ac bridge network, the control section, and the bridge balance discriminator. After an operator has inserted a punched card into the reader, he presses a button which causes the conveyor to index the capacitor to the first station and initiates transfer of data from the card reader to the central control unit. This unit sets the proper resistance in the range arm of the bridge and starts the Opcon process sequence control which statically balances the dissipation and capacitance arms of the bridge to a null position to determine the actual capacitance of the unit under test. The bridge balance success or failure discriminator determines the magnitude and direction of moves to be taken by the optimizing control to achieve the balance condition of the bridge. When the bridge null position is obtained, the capacitance value is fed into a visual readout device and into the central control where it is compared to the design tolerances. The central control then determines whether to accept or reject the capacitor under test. If the capacitor is rejected, all other test operations are cancelled. Accepted capacitors move through the remaining test operations. After these tests, the capacitance of the unit is tested again in the same manner as the initial capacitance. If the final capacitance varies more than 1 per cent from the initial measurement, the unit is rejected.

Conveying Problem Materials

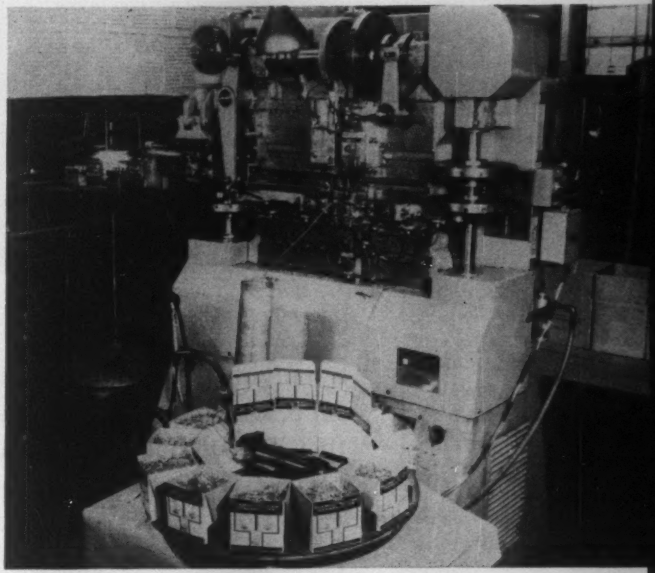
PLASTIC conveyor belting made of DuPont Mylar polyester film is being used by many companies to handle problem products. Furnished by Lassiter Corp., the belting is strong, smooth, flexible, crackproof, nonabsorbent, immune to attack by oils and greases, stable under temperature and humidity changes, and has good heat transfer properties. In the example shown, a 32-inch wide by 128-foot long plastic belt carries candies through a cooling tunnel maintained at 40 F at the Goldenberg Candy Co., Philadelphia. The smooth surface of the belt imparts a glossy appearance to the bottom coating of the candy and provides fast cooling since the material dissipates heat more rapidly than fabric belts. The Gates Engineering Co. is using the belting to process sticky calendered rubber stock. Other uses of the belting are for handling sauerkraut, for conveyor line freezing of food products at temperatures of minus 40 F, and for handling bakery products such as conveying doughnuts from a frying vat to a sugaring bin.

Rolling Ingots

PUNCHED card control of a 46-inch reversing mill at the Indiana Harbor Works of Inland Steel Co. has improved slab quality, increased production, and reduced operator training time. The mill was built by United Engineering and Foundry Co. and is powered by a 12,000-hp main drive and a 4000-hp edger drive furnished by General Electric Co. Capable of rolling a 20-ton slab in 1½ minutes, the mill has been in operation for a year and a half and is operating at an annual capacity of 1.6 million tons. All normal shaping of ingots can be performed automatically and as many as 23 passes can be programmed on a single punched card. Roll speed, direction, screwdown, and mill table operation are controlled by punched card and a General Electric control system. To guard against possible damage to the mill, a closed circuit television system permits the operator in the control room over the delivery side of the mill (in background) to gage and reject oversized ingots at the mill entrance in the foreground. During rolling, a series of hot metal detectors sense the position of an ingot within the mill and feed back signals to initiate the passes.

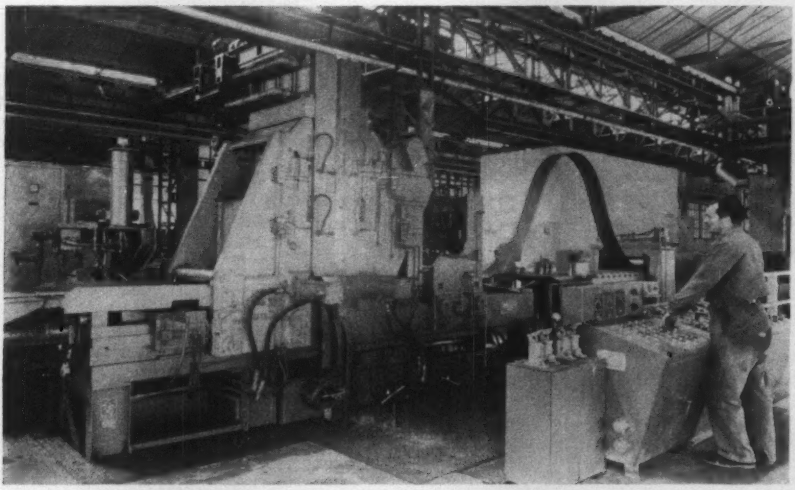


in action



Forming Hanger Clips

APPROXIMATELY 8000 wire hanger clips per hour are automatically formed and packaged on this vertical four-slide machine and indexing packaging table installed at Cuyahoga Products Corp., Cleveland. Clips are made from 0.0475-inch diameter coppered steel wire on the uncoiling stand at the left. After passing through two sets of straighteners, the wire is formed into clips on the four-slide machine and ejected onto the guide rod leading to the indexing table. The clips slide down the rod, drop into the vertical tube, and fall into a paper carton. After a carton is filled with 1000 clips, the table automatically indexes counterclockwise to move the next empty carton into position under the tube. Operator attention is required at machine only to replace cartons every hour and a half and to install new coil of wire several times a day. The wire forming machine was built by Torrington Mfg. Co.

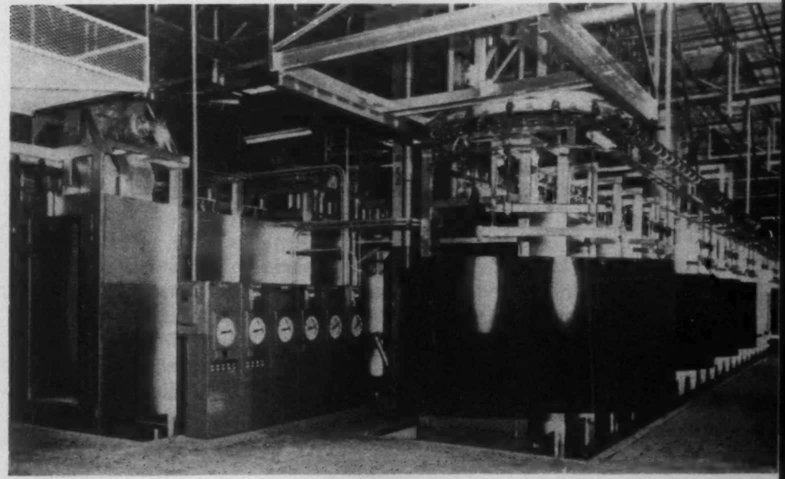


Welding Strip

STEEL strip cleaning and preparation line in the plant of Fiat Stabilimenti Di Avigliana in Northern Italy uses this Sciaky Bros. Inc. welding machine to butt weld new coils of strip to the steel being processed. As the old coil runs out, the operator slows and stops the strip when it is positioned in a shear out of the picture to the left. After shearing, the operator allows the strip to run past clamping dies of the welding machine, stops the strip, raises a gaging bar, and then reverses the strip against the gaging bar. During this time, a new coil has been fed into the machine, and the operator causes its end to be sheared and positioned against the gaging bar. With the two ends in position to be welded, the operator lowers the gaging bar and initiates the welding cycle with a pushbutton. The two strip ends are automatically moved to each other, welding current is turned on and a flashing action occurs, and then the hot ends are driven together in a forging action. After welding, the joint is pulled through a set of trimming blades, and, if necessary, the weld is automatically heat treated to reduce localized hardening.

Firing Glass Coated Sheets

RECENTLY placed in operation at A. O. Smith Corp. is this 180-foot long, U-shaped porcelain enameling furnace for firing glass coated structural sheets. The furnace is part of an automated production line which processes steel sheets through forming, washing, grit blasting, liquid glass spraying, oven drying, and finally glass-fusing operations. The 5 by 9-foot curved sheets enter the furnace through a kinetic air seal and pass through three heating zones. The first zone heats the sheets to approximately 1250 F, the second zone increases the temperature to about 1520 F, and the third zone heats at a reduced temperature of about 1440 F. Sheets travel through the furnace at 35-second moving and 45-second standing cycles and remain in the heating sections for a total of 10 minutes. After heating, the sheets pass through a refractory-lined precooling zone and then into a water-jacketed cooling section where the sheet temperature is dropped from 1000 F to 400 F. An air-cooled section then cools the sheets slowly to about 100 F before the sheets pass through another air seal and leave the oven. The furnace was designed and installed by the Industrial Div., Lindberg Engineering Co., and has a capacity of 13,500 pounds of sheets per hour.



ENGINEERING COSTS—WHO PAYS?

Part 2

Supplying automated equipment for modern production processes may involve engineering special machines that are unique to the product line they make. This requires engineering for proposal, design, and debugging. Both buyers and sellers are concerned. Part one presented the buyers' view. Four sellers conclude the series by stating their case.

SELLERS' POINT OF VIEW

By J. R. BAREFOOT
President
Federal Machine & Welder Co.
Warren, Ohio

THE PROBLEM of "before and after" engineering costs is one that is currently plaguing the manufacturers of special machinery lines. It will grow even more acute as machinery becomes more complicated and builders are required to produce an ever widening range of assemblies with a minimum labor cost. Just to comprehensively quote an automated line of machines to produce the more complicated assemblies has become an engineering feat, and to quote competitively and make a profit, borders on the miraculous. The engineering costs incurred in simply working up an understandable quotation complete with sales proposal drawings are substantial and sometimes amount to more than the smaller manufacturers, who specialize in this type of equipment, can afford, either in dollars or in time. Certainly, something must be done to compensate those companies who do a good job of quoting and who do not simply borrow the ideas of their competitors when the job is requoted.

Quotation Fee

The concept of charging an engineering fee for a quotation to a customer may not be in keeping with the principles of free enterprise and existing mar-

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This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

keting practices in our industry, however, quotations on special lines of automated machinery no longer simply offer an item of equipment for sale, but they actually perform an engineering function which, prior to the last few years, normally has been performed by the customer's methods and process department. Instead of utilizing their own engineers to develop the proper methods and sequence of operations for a particular assembly, the trend is to have these engineering functions performed by prospective suppliers of the equipment for producing the product.

At the present time there are a great number of companies quoting on special lines of this nature with some preparing lengthy, documented engineering quotations and others submitting just short quotes with "We Will Do the Job for You" statements which rely too heavily on the faith of the customer. This latter group more oftentimes than not are lower in price, sometimes purposely so, and other times through plain ignorance of the problems involved, not having analyzed the job to a sufficient degree. As is so often the case, the special lines will be requoted more than once, and by the time an order is finally placed, each bidder has become acquainted with everyone else's ideas to the point where practically all the major problems have been worked out and he is ready to design and build the line.

Why not have a standardized engineering fee for line type quotations? The customer would soon learn upon whom to depend for a clear, comprehensive engineering type quotation, presenting ways and means for most economically producing his product. The supplier who turned in an inadequate quotation without sufficient engineering consideration would automatically be eliminated from future requests for quotations, since no one will continue to pay out dollars unless value is received. Suppliers who have little besides manufacturing facilities would be eliminated in favor of those with engineering know-how. Obtaining too many proposals, which leads to confusion and uncertainty in everyone's mind, would be eliminated. Certainly in this day of competition, three or four reputable suppliers will insure the customer quality equipment at a fair price.

Methods of pricing engineering quotations can be developed. For example, costs could be averaged out and a dollar figure assigned to special lines by numbers of active stations and/or operations. A fair price per active station or operation should not cause any burden on a company honestly intending to purchase such equipment, but would partially reimburse the supplier for the preparation of a comprehensive, engineering type quotation. Additional revised quotations could be priced at a reduced figure.

▶ Tryout Charge

The above is suggested to handle "before costs." "After costs" are not as easily estimated, and can vary widely from job to job and do not seem to have any relationship to the initial complexity of the job. The most simple-looking minor problem in the quotation stage can turn out to be a major problem during the tryout of the line. This can completely drain the job profitwise. However, manufacturers of special automated lines are building up a backlog of data on tryout or "debugging" costs and should be able to average these out over the number of active stations or operations. These can then be presented as a charge for tryout of the line in the supplier's plant with the hopes that no more than an average number of problems will develop during this period of tryout. In addition, a small percentage figure, in the neighborhood of 5 per cent of the entire line cost, could then be quoted as "Compensation for Unanticipated Problems." Upon mutual agreement of the customer and supplier, unforeseen problems could then be compensated for up to the amount of the percentage figure. This would not differ greatly from many customer's practices of allowing a substantial cushion in their appropriation for the tryout of special machinery in their own plant using their own personnel. By allowing such a flexible cost for such unforeseen problems, the customer would share the risk to some extent with the supplier.

▶ Engineering Charges

The idea of quoting and purchasing each phase of the engineering separately is forthwith rejected. There is a great deal of difference between engineering a line which has already been sold at a fixed price, and just engineering a line whose price will be quoted after engineering completion. In the first case, calculated engineering risks are taken to minimize costs and these are not usually to the detriment of the line since the line must ultimately be made to work by the same supplier during the tryout period. In the latter case, it could simply be a question of taking the easy way out with all the expensive gadgetry and extra operations necessary to insure that there will be no trouble with the line. This is certainly not the method for building equipment at a minimum cost. The idea of paying for engineering on a per hour basis is also rejected. Too often the best ideas result from many hours of scratch sketching and hard thinking which result in relatively few lines on the layout paper. It is hard for a customer to see this type of engineering cost and believe that he is receiving his money's worth.

▶ Partial Solution

In the absence of any uniform method in the industry for adequate compensation for engineering costs, any method that is proposed will probably take many years for acceptance by both customers and suppliers. In the meantime, the partial solution to this problem is for customers who require equipment of this magnitude to select and work with three or four potential suppliers who have demonstrated ability (from the standpoint of engineering, plant facilities, and financial condition) to supply quality equipment at a fair price. After selection of a source, they should work closely with the supplier and be willing to negotiate with him on unanticipated engineering problems and costs, so that the project will be mutually beneficial.

By L. P. GAJDA
Vice President—Engineering
Snyder Corp.
Detroit, Mich.

THERE HAS BEEN a great deal of discussion lately about who should pay the costs of engineering a piece of production equipment. Engineering is a commodity that costs any builder of machinery a lot of money. Today a machine builder who cannot put engineering know-how into his developments will not be in business very long. And those who may have made the mistake in the past of giving away engineering work without charging for it are probably out of business now.

In the area of automation, it is in reality only engineering that is the main commodity. There are many manufacturers of machine tools who have excellent machine shops and competent toolmakers, machine assemblers and electrical and hydraulic technicians for building machinery. But ability to build and deliver a machine is not the main reason that it is first considered and ultimately purchased. The attributes that make a machine worth its investment by cutting cost, reducing floor space, increasing product quality, increasing production rates, or making the manufacture of a particular design feasible are chiefly a matter of engineering. Certainly if engineering can provide all of these benefits it is a commodity worth buying by the customer.

Machine Tool Trends

For many years machine tools were standardized designs that were made up in quantities, stocked, and sold with only a small portion of the total resulting sales price representing engineering. Basic designs for general purpose milling and drilling machines, for instance, remained basically unchanged for decades. But when all of the advantages had been taken of such standardized designs, the special machine became a feasible solution to the continuing problem of cost reduction.

Out of these trends toward automation came the need for greatly increased engineering know-how to create machines that would meet high production schedules while maintaining maximum product quality at minimum cost.

Take for a specific example the rotary index type machine, *Fig.* 1, which was the next step beyond the use of separate drilling and tapping machines having multiple spindle drill heads. This machine has a one-piece base, hand clamping, and manual lubrication. It is hydraulically operated, electrically controlled, and has minimum part flexibility.

Now what would you do to make a machine of this type produce more, have more flexibility, make more accurate parts and do all of this in a minimum of floor space? In *Fig.* 2, is shown the much more sophisticated type center column machine that performs many more operations and provides the suggested improvements over the rotary index machine of simple design.

The automated machine in *Fig.* 2, has automatic hydraulic fixture clamping, provides vertical and horizontal machining operations, uses two-position fixtures, and has building-block flexibility. It handles a variety of different parts and uses a unique double index system to complete the machining of two sides of a part by processing it twice around the machine. Automatic lubrication is also provided. Granted, the latter machine is a masterpiece of automation. But how much of the difference in cost is engineering? And how much is in manufacturing?

The rotary index machine in *Fig.* 1, costs about $35,000. About eight per cent, or $2800 represents the cost of engineering this simple machine. The center column machine costs about $120,000. Approximately twenty per cent, or $24,000 is the cost of engineering this high-production machine. From this comparison you can see that the percentage of cost in engineering the automated machine is nearly three times that of the simple index machine. No machine tool builder could stay in business very long and give away $24,000 bills with a $120,000 machine. He could make some adjustments downward if there would be another machine or two like it built at the time, or ordered later. Sometimes those later orders for duplicate machines never come. But if and when they do, of course, the engineering costs are considerably less. It always seems, however, that even if a machine is reordered as a duplicate, there are a myriad of design changes that are wanted by the customer.

We in the special machine tool business have done a great many things to try to help cut the cost of engineering automated machinery. For many years we have used standardized designs for machining units, bases, and index mechanisms to cut engineering and manufacturing time. Often, however, it is the application of a special unit here and there along a transfer line or around a center column that enables us to cut a cost, get an operation "free," or even garner the order on the basis of a resulting lower competitive cost.

Engineering is certainly a legitimate cost to the customer. We know that this is a cost that can be amply justified when tangible production savings result. However, if the engineering that is put into a machine cannot justify itself in terms of production cost reduction it is certainly not worth paying for.

▶ Quotation Costs

Another problem of building engineering into automated machinery comes about as a result of the manner in which such equipment is usually purchased. Usually an entire automated machine is estimated and submitted for a competitive bid in an extremely short period of time. This means that often these quotations are educated "guesstimates" made on the basis of broad experience, similar machine costs, and internal rules of thumb. More than one machine tool builder will admit that, under such haphazard conditions, either the customer, the builder, or both have wound up with unsatisfactory experiences.

Machine tool builders in the special machine field actually give away a great deal of engineering today in the form of hours put in on quotations for which they quickly and eagerly study, create, and develop designs, only to lose the order along with many other of their competitors who have estimated the same job. Today a machine tool builder of necessity must choose carefully the machines on which he quotes. Of course, this is done on the basis of who else is quoting, and general attitudes regarding the chances of getting the order if a satisfactory quotation is turned out. It is relatively easy to go out of business turning out well-engineered quotations and getting only a few orders in return.

If there were one suggestion that could be made to cut down the charges that have to be made for engineering, it would be in the form of reducing the hours put in on quotations which never result in orders. Engineering prices unfortunately have to be geared to carry much of this "quotation overhead."

I don't believe that any of us in the machine tool business wants to cut out entirely the competitive situations that help assure industry that it is getting its equipment for minimum cost. I don't believe either that any of those individuals procuring equipment in industry are anxious for any of their suppliers to go out of business. I do think, however, that industry has an obligation to keep the number of companies quoting on a particular machine to a minimum. I also think that in selecting those to quote, they should have those of similar staffs and proved capabilities quote on the same job.

Industry would get the most out of its engineering for automation if it would buy the design program development concept in which actual engineering hours are billed in process. Then when the design is finalized, the machine could be quoted and built.

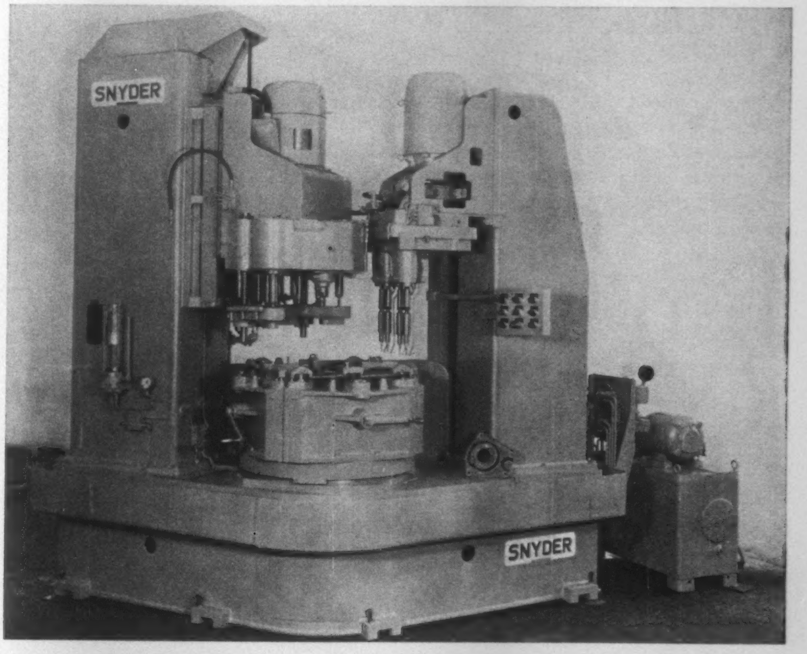

Fig. 1—Typical rotary index special machine tool without automation refinements. About 8 per cent of its cost represents engineering design work.

A great deal of misunderstanding between builder and customer has resulted because, even after the design is put into the shop for building, changes were made by the customer. It costs a large amount of money to make a change after a machine is in the process of building. And it may take only a few minutes to make the change when it is in the design stage.

We have found that design programs can be speeded up by overlapping design and checking procedures. Also it may often be more expedient to let a design clear the drafting room to completion and then make necessary changes. This is in contrast to the method where the design is continually interrupted for changes.

Other Industries

The preceding remarks have dealt mainly with engineering costs in the special and automated metalworking machinery field. Our company also manufactures automated machinery for the chemical, pharmaceutical, cosmetics, paint, and food industries. It is interesting to note that the engineering cost situation is the same in these fields. Tablet presses for manufacturing drug tablets from powdered granulations are made in more or less standardized designs. Producing at rates up to 6000 tablets per minute, these machines are outstanding examples of machines embodying continuous production automation principles. However, they are made and stocked in a line of several standardized models. Engineering costs are relatively insignificant compared with the cost of any individual machine.

In the pharmaceutical field there is a great demand today for highly automated filling machinery. Some of these machines can cost as much as a transfer machine. And the engineering costs represent a large portion of the total cost. The pharmaceutical industry in particular has taken a slightly different attitude about special machinery. They have utilized with considerable success the separate design program—build program concept. Many times engineering costs go far beyond what a quick estimate without study would dictate. However, in the packaging and filling field, the savings from automation can easily carry heavy engineering costs if the machine works.

It is this "if the machine works" statement on which all engineering investment discussions should hinge. All of us in the machinery business know that if engineering cannot justify its cost it is never sold again. On the other hand, engineering that

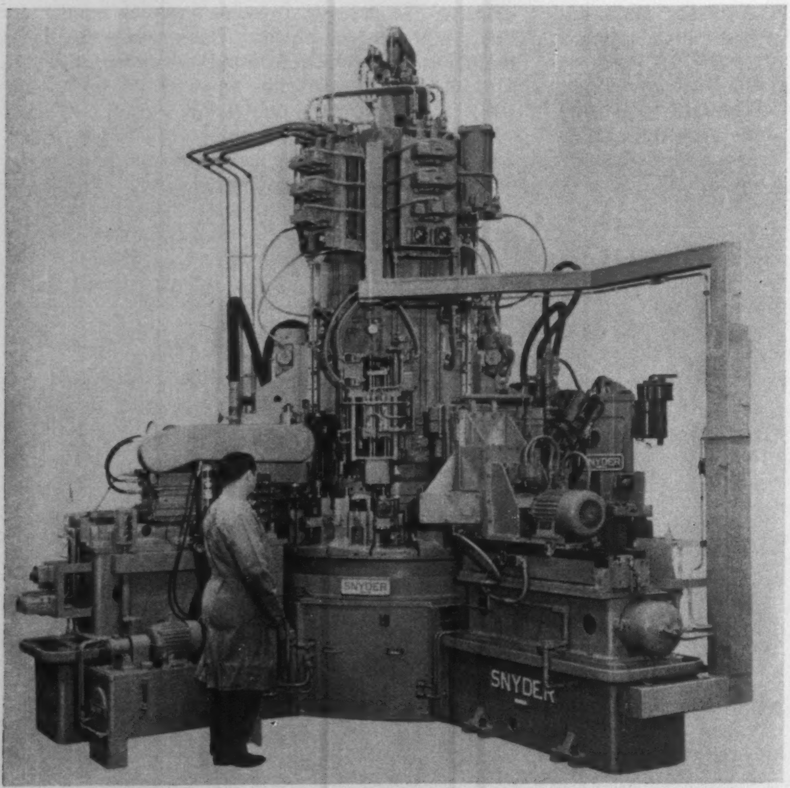

Fig. 2—Center column type of special machine tool embodying automation refinements. About 20 per cent of the cost represents engineering design work.

does justify its cost is the one commodity in which our large current investment in automation is based. Industry needs engineering to help increase production and cut product costs. It should certainly be willing to pay for it when it accomplishes these goals.

By E. L. McFERREN
Vice President—Sales
Giddings & Lewis Machine Tool Co.
Fond du Lac, Wis.

TITLE of the subject for discussion is "Engineering Costs—Who Pays?" The subject is put forth in the form of a question, and it would appear that the elementary answer to the question can be stated very simply. The customer must pay for engineering.

Within the bounds of sound economics and with the basic assumption that engineering has been and will probably continue to be done by companies who have established businesses and who expect to maintain their business through a return for their work, the only conclusion which seems reasonable reverts to the above answer. The customer must pay.

This assumption I believe to be completely logical and true, but a large problem still exists concerning the question of which customer pays and how equitably the charges for engineering are distributed. Also, how can industry as a whole more efficiently use engineering effort?

▸ Machine Tool Building

Before going into observations intimately connected with the subject, it may be best to describe the functions of a machine tool building firm. We need to see the relationship between engineering and the other factors involved in the production of finished industrial tools. I can best use an example furnished by the operation of the company which I represent. At Giddings & Lewis, we operate a machine tool company where we consider ourselves to have four functions of roughly equivalent importance. These four functions are engineering, production, sales, and finance. In administrative and executive capacity, these four departments are given equal consideration. We sincerely believe that an out-of-balance condition in any one of the four areas will result in an unhealthy business. Of course, we consider the machine tool business to be an engineering business, and the administrative and executive manpower of all of the functions is heavily loaded with men of engineering background. With the possible exception of finance, we believe the engineering background and understanding is essential to our well-being.

We subscribe to the normal theory that the overriding purpose of a machine tool company is to place in the hands of customers industrial tools which will effectively fulfill the customers' needs in a competitive, economical manner. On the other hand, we do not lose sight of the fact that in the fulfillment of this purpose the incentive which holds us to our task and perpetuates the life of our corporation is the profit which we also must derive from the customer. With these generalized thoughts in mind, I would like to return to the specific problem as to engineering costs and who pays.

Fundamentally, we subscribe to the theory of selling engineering over and over as the only efficient way to use the ingenuity, effort, and attention which go into machine designs. In our manufacture, we produce many types of machinery which we term standard lines. In the instance of the standard line machines, the engineering is highly developed and refined. Constant revisions and changes occur in these lines to reflect the great amount of field testing which occurs in the machine's use. Continuous attention is given the engineering in these standard lines to keep abreast with developments in technology, both in the machine tool field and in the related fields of metal cutting and advanced material uses. In the standard machine lines, we have come to regard the relationship between engineering use, machine production, and customer satisfaction as close to ideal.

▸ Demand for Specials

Despite the conditions and relationship cited in standard lines, we find that, in times of high competitive stress, machine tool users turn from the use of standard line machines and demand machine designs which are tailored to do a specific task with the highest degree of efficiency. The machine tool builder has no quarrel with this condition as it is recognized that the tools of production represent a relatively low percentage in the total cost of manufacturing. Higher machine costs are offset against many units, and any small degree of increased efficiency in production may quite easily justify the departure from standard tools. However, despite this recognition, there still remains a problem, and usually a quite controversial problem, as to the costs which should be normal when the departure from standard machines is made.

It has been the experience of many machine tool builders that buyers of tools have formulated opinions as to the reasonableness of engineering costs through their long experience of buying standard tools. Many times they are very poorly equipped to evaluate the great variable in costs that may occur when engineering is performed on a specialized basis. We have even experienced situations where special machines are evaluated on a per pound basis.

To give some illustrations, I will again refer to experiences within our own manufacture. In the engineering and production of standard line machines, we have customarily operated where 5 to 10 per cent of the sales dollar has represented the effort of cost of the engineering function. This presupposes, of course, that the engineering be used many times. It does not, however, imply that the standard lines are in any way lacking in high grade engineering. As opposed to our experience in standard line machines, we have quoted and sold, in many instances, special machine applications where the engineering and related service and educational efforts have been as high as 30 and 40 per cent of the tool's cost. I might add that, usually, when these high engineering costs are encountered, they have been resented by purchasers who are still carrying the 5 and 10 per cent as a yardstick in their machine tool evaluation.

We have further found that in most instances where machines have been bought for special purpose work and to special design specifications, they very rarely match specifications and design requirements issued by other customers who are competitive manufacturers of like products. Thus, we have come to the practice of assuming that engineering costs for the specialized applications must, to a large degree, be borne and written off against each specific job which is sold.

Of course, there are a great many engineering features which, even in specialized machinery, can be used over and over, and certainly there is a vast know-how built up in an engineering department of long standing which minimizes the cost of special engineering. Despite this fact, engineering costs for specialized machinery usually exceed the customer's expectations, and I may say, regretfully, that quite often they exceed the builder's expectations. When the latter case occurs, and we return to our original premise that the customer must pay under these circumstances, we find that in some instances the customer who pays is not necessarily the customer who receives the benefit from the special engineering.

Regardless of the occasional miscarriage of justice or judgment—whichever it may be—in the assessment of these engineering costs, most machine tool companies are equipped to make a proper apportionment of costs to their products after an order has been secured. Estimating departments gradually acquire a degree of efficiency, and competitive conditions enforce an alertness which eventually causes inequalities to be leveled out. This condition, however, is not necessarily true in the instance of engineering work which is expended in the proposal field.

Proposal Engineering

Following the periods of high production in World War II and the Korean War, we have seen a great change in the attitude and emphasis by the manufacturing divisions of most industrial companies. During the high production war years, emphasis was on production volume, and the attainment of a profitable operation was relatively easy. Standard machines were generally specified in buying programs because of their availability and favorable pricing. In most instances, the addition of up-to-date standard tools into production facilities which had been operating with equipment of considerable age produced quite satisfactory output gains.

However, after the war conditions passed out of the immediate picture, we returned to a much greater degree of competitive activity. The competitive situation encouraged the buildup of the industrial engineering function. Keen competition, practically static labor output, higher taxes, foreign competition from the cheap labor countries, and the partial loss of defense markets have placed management in a position requiring the production of a profit under much more adverse conditions. Most managements are placing their greatest hopes of meeting these demands through an improvement in the tools of production. The reasoning of many managements follows the course that such improvement must be specialized to their own specific production problem. Consequently, many managements have developed industrial engineering staffs who are giving a great amount of time to the analysis of their production problems and their solution. One of the results of these efforts is the specification by industrial engineering staffs of specialized equipment.

Particularly aggravating in the solution of these problems is the fact that so many new industrial engineering staffs have been created that of necessity they have incorporated personnel unfamiliar with machine tools and their design. In order to make up for this deficiency, in many instances the staffs of the industrial engineering departments are culling their information and gaining their training through requests for bids from the old line machine tool companies. In some instances, the requests for bids are in good faith and eventual orders are placed. In many instances—and this has been true particularly during the past recession—the invitation to bid has not been in good faith. Regardless, in calling for elaborate proposals in many cases three, four, five, and six elaborate proposals have been made by different machine tool builders at extensive cost where, of course, only one can be used if the request for bid has been in good faith.

A still more serious problem to many machine tool builders is the growing practice of calling for a first round of proposal bids and gleaning from the information received a sufficient picture of features for the reissuance of a composite specification for a second round of proposals. This, of course, is an expensive and extremely inefficient use of the very limited engineering capacity presently existent in the machine tool field. It also has the further complication that in many instances the composite specification leaves the machine desired outside the building capacity of any of the individual original bidders.

This situation has been particularly common during the past severe machine tool recession. There is, apparently, no easy way to curtail this practice, but it is equally true that, by no stretch of the imagination, can this waste of engineering be considered to be free. It eventually must be paid for, and—returning to the original premise—it must be paid for by the machine tool customer.

▶ Outlook

In the company which I represent, we are of the opinion that there will be a continued increase in the purchasing of machinery which departs from the standard line. We are also of the opinion that when the first few years have passed in which special machine applications are made to specific jobs, the task will become immensely more difficult to secure a manufacturing advantage through this route.

We feel certain, however, that competitive conditions will force manufacturing of most commodities into standardized products which can be produced in some volume. As conditions stabilize in these manufactured commodities, there will be an eventual approach to a recognized good practice in machining the commodity components. This, in turn, will complete the cycle, and the machine tools used for the component manufacture will again come to a point of being standard lines.

In the meantime, many companies will review their purchasing practices, and possibly many machine tool builders will review their proposal practices. We may reach a result which may place machine tool engineering and machine tool proposal work on a basis much similar to that of the architect's place in the building trade.

In the meantime, I think it highly appropriate that industrial engineering staffs become acquainted through the medium of trade paper articles, popular journal articles, professional society publicity, and all other means possible of the fact that engineering time is a scarce, expensive commodity. Each hour that is spent in engineering work, whether it be in the design of a gear train or casting, or whether it be spent in proposal work, has cost some machine tool customer between $5 and $10 in the current scheme of evaluation.

Machine tool builders, in this instance, act only as the middle man, or the retailer of the service. The company calling for the service and receiving the benefits must pay the bill.

By W. K. STOKES
Vice President—Sales
Alvey-Ferguson Co.
Cincinnati, Ohio

AT FIRST this may sound a bit trite, and we are likely to get a variety of answers, one of which would be that this is merely one of the costs of doing business. In a sense this is true, but inevitably engineering costs must be passed on to the customer.

We are not referring to the cost of making detailed shop drawings since it is standard procedure to figure this cost into the price for the job. Our reference is to the cost of preparing an estimate before an order is placed.

On most new construction, plans and specifications are prepared by engineers and architects who are paid a fee for their work. The various bidders prepare their quotations from this predetermined information. This is not true of the bidding on most material handling, treating, and finishing systems.

We must admit that this is to a large degree the result of our own method of operation. We all like to have complete latitude to show what we can do, and prepared specifications generally tend to cramp our style, especially if they are written around the competitor's construction.

Originally, the preparation of a bid was a fairly simple matter. Package handling conveyor systems consisted of roller conveyor sections, both straight and curved; pusher bar boosters; slides; and manually operated switches. A salesman armed with some unit prices and a reasonable amount of know-how could quote a sizeable job for a brewery or distillery without ever contacting his home office, except possibly for a little help on the actual drawing of the layout.

With the advent of mass production and special assembly conveyors, the problem became more complex, but still not too bad. However, with the present-day complexity of layouts—involving automatic transfers, selective deflection, electronic memory systems, and split second timing—the picture has changed.

We now require electrical and mechanical engineers, as well as trained draftsmen, plus an extensive knowledge of costs and what is available in order to make a quotation today. Naturally, this boosts the estimating costs.

We think everyone will agree that the old adage, "You can't get something for nothing," is just as true today as it ever was. Yet we find more and more people seemingly expecting it. Their argument is that the only way they can be sure of getting the best idea for doing a job is to get the thinking of as many different people as possible. If this is necessary, then the customer should be willing to pay for the service. When you go to your doctor and request a consultation, it is customary to pay the consultant. Or, if you go to an architect to have some plans drawn, you pay for the service. In fact, you pay each time they are changed. In our business we often make several complete, and often different, layouts without being paid for any of them if we lose the order.

▶ Number of Bids

It is not uncommon for the customer to ask several companies to send engineers halfway across the country to discuss his problems, when he knows full well there is only one order to be placed. Sometimes this happens even when he knows where he will place the order after he decides which is the best way to do the job. Fortunately, the latter is in the minority.

Frequently, five or more bidders are asked to quote the same job, which can easily take several man-weeks to complete, and $2000 to $3000 is spent by each before anyone gets an order.

A classic example of the extreme to which this can be carried came to light several years ago. We were asked to bid on a small job which ran less than $1000, but required some layout work and a detailed estimate. The purchaser inadvertently sent us all copies of the bid requests—all eighteen of them.

Several firms probably would not bid, but assuming they did, and that the estimating costs were a very nominal amount of $60 for each bidder, the total cost of bid preparation would have been more than the amount of the order.

▶ Estimate Costs

The total cost for operating our Estimating Dept. during 1958 represented approximately 5 per cent of the total volume of sales for that period. Actually, this percentage figure would be much greater if based only upon the total for the strictly engineered jobs. The average ratio between the cost of estimating and the total dollar value of the estimates written is approximately 1:150; that is, $1.00 cost for each $150 of estimates.

As can be seen, these figures indicate that the cost for preparing estimates is far above what is generally considered normal for this service, and is deserving of serious consideration.

We understand that in Europe they are not so free with their engineering talent. For instance, in certain heavy industries in Britain, the bidders on large projects enter into an informal gentlemen's agreement, and add a predetermined percentage to their bids. For example, if each of five bidders on a $500,000 project added 2 per cent to his quotation, he would be adding $10,000 to his base bid.

The successful bidder upon receipt of a contract would then be obligated to pay each of the four unsuccessful bidders an equal share of the amount added to the bid—or $2500 each. This would not cover the entire cost of preparing the bid, but it would most certainly help.

On a number of occasions the British Monopolies Commission has examined this practice but has concluded that it is not against "public interest or welfare." Such an arrangement encourages competitive bidding, but at the same time holds down the cost. It would also tend to discourage the requesting of so many bids for one project. Such an arrangement would have to be kept strictly on an informal basis so as to avoid suspicion of price-fixing. This is offered merely as one idea and not as the solution.

We think this is a problem which deserves a lot of serious consideration and sincerely hope that a germ of an idea for a solution may come from these discussions. However, no matter how it is handled, we think this cost should be paid only once.

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transactions available

The complete transactions of the "Fourth Conference on Manufacturing Automation" are printed in a 96 page booklet that can be obtained from AUTOMATION, Penton Building, Cleveland 13, Ohio for $2.00 per copy.

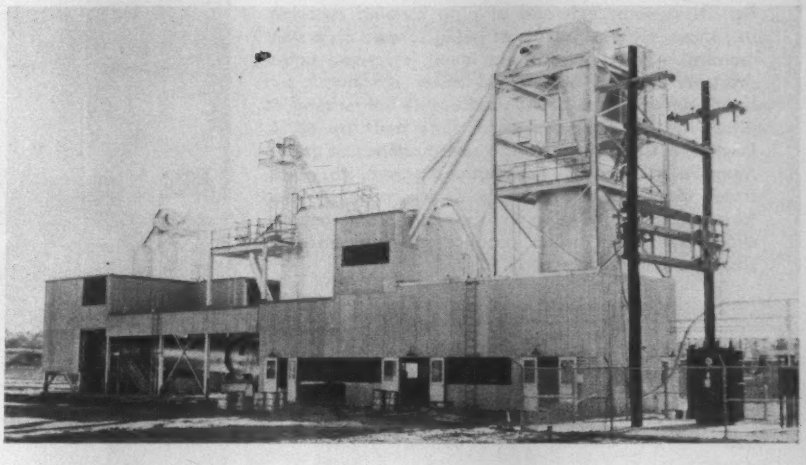


Fig. 1—Preparation of silica, one of the raw materials used in the manufacture of asbestos-cement pipe, is carried out in this building at the Denison, Tex., plant of Johns-Manville Corp. Here, incoming supplies of sand are dried, ground in a ball mill, screened, and stored for subsequent use in pipe production.

MAKING ASBESTOS-CEMENT PIPE

HIGH SPEED production of asbestos-cement pipe, in two standard lengths and a variety of diameters, is being achieved with special equipment in a new pipe plant of Johns-Manville Corp. at Denison, Tex. The production equipment and process layouts for the new plant were designed by the company's General Engineering Dept. to performance specifications of the Pipe Div.

Transite pipe, as the product is called, is made from three principal ingredients: Asbestos fibers, cement, and silica. Mixed in preset proportions, the ingredients are consolidated under pressure to form pipes having dense, uniform walls. After formation, the pipes are subjected to a steam curing process that improves their stability and structural strength. The resulting product is a strong, corrosion-resistant pipe suitable for underground piping and industrial lines. For example, such pipes are used for water and sewer systems, irrigation, electrical conduit, ducts, vents, flues, and stacks.

▸ Raw Material Preparation

In the design of the plant, special consideration was given to the problems of handling and process-

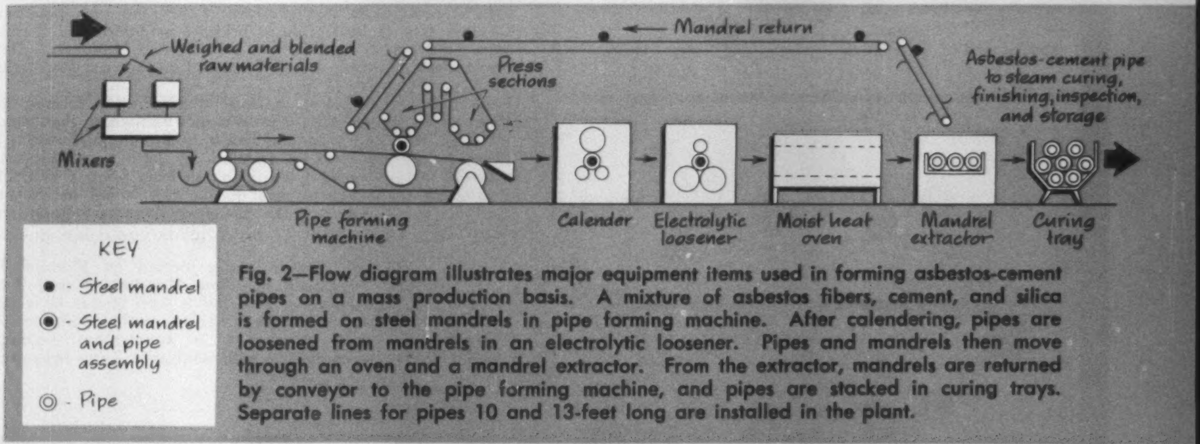
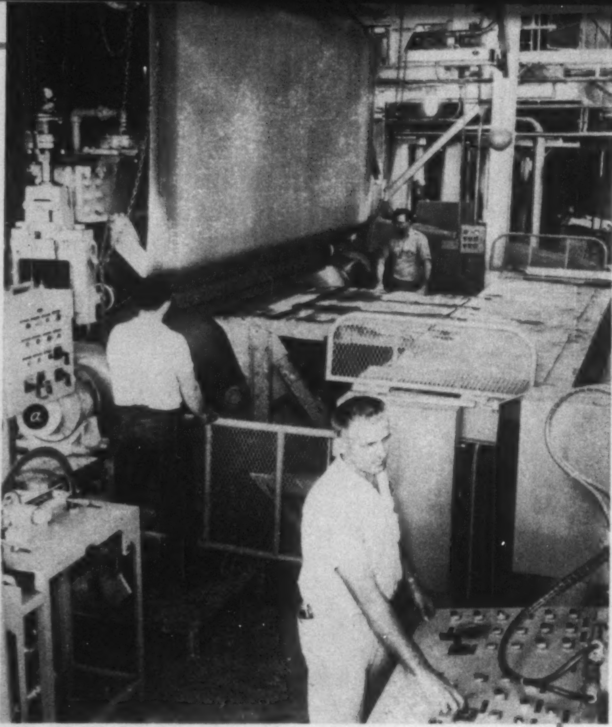
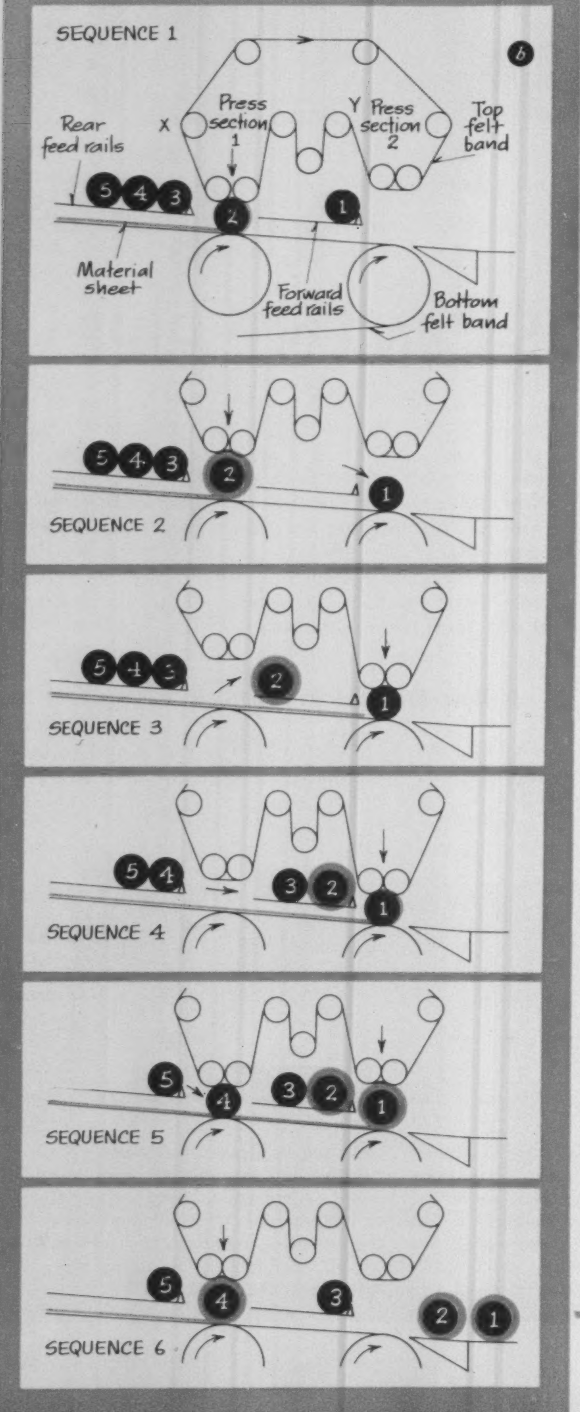

Weighed and blended raw materials
Mandrel return
Press sections
Asbestos-cement pipe to steam curing, finishing, inspection, and storage
Mixers
Pipe forming machine
Calender
Electrolytic loosener
Moist heat oven
Mandrel extractor
Curing tray
KEY
● - Steel mandrel
◉ - Steel mandrel and pipe assembly
◎ - Pipe

Fig. 2—Flow diagram illustrates major equipment items used in forming asbestos-cement pipes on a mass production basis. A mixture of asbestos fibers, cement, and silica is formed on steel mandrels in pipe forming machine. After calendering, pipes are loosened from mandrels in an electrolytic loosener. Pipes and mandrels then move through an oven and a mandrel extractor. From the extractor, mandrels are returned by conveyor to the pipe forming machine, and pipes are stacked in curing trays. Separate lines for pipes 10 and 13-feet long are installed in the plant.

Fig. 3—View of exit end of pipe forming machine, *(a)*, shows pipe in process of being formed on a steel mandrel. Pipe, at platform level, is formed under pressure between upper and lower continuous felt bands. Two press sections alternate in forming of pipes in the machine, which was built by M. L. Bayard & Co. Inc. to design specifications of Johns-Manville engineers. Schematic diagram, *(b)*, illustrates sequence of operations of the machine when forming successive pipe in alternate press sections. Unit may be set up to produce pipes of different size in each press section.





OPERATIONAL SEQUENCE—
Pipe Forming Machine

Sequence 1. In the condition shown, there are five mandrels in the machine. Mandrel 1 is stopped by a holding device on the forward feed rails; Mandrel 2 is under Press Section 1 which is in its lowered position; and Mandrels 3, 4, and 5 are held on the rear feed rails. The machine is operating, with the top felt band driven from point *X*. The material sheet is beginning to build up on Mandrel 2.

Sequence 2. Just prior to completion of a pipe on Mandrel 2, Mandrel 1 is fed into position beneath Press Section 2. Mandrel 1 is held in position by an auxiliary stop (not shown).

Sequence 3. When a pipe has been formed to the required diameter on Mandrel 2, the top felt band drive is changed to point *Y* and Press Section 2 is lowered onto Mandrel 1. At the same time, Press Section 1 is raised and Mandrel 2 is placed on the forward feed rails. This action breaks the material sheet and permits its leading edge to travel to Press Section 2 for pickup by Mandrel 1.

Sequence 4. While a pipe is building up on Mandrel 1, Mandrel 2 is allowed to roll down the forward feed rails until it reaches a stop. Following this, the gap between the two sets of feed rails is bridged and Mandrel 3 rolls onto the forward feed rails to stop behind Mandrel 2. This also brings Mandrels 4 and 5 forward on the rear feed rails.

Sequence 5. Just before a pipe is completely formed on Mandrel 1, considering the distance between the press sections, Mandrel 4 is positioned under Press Section 1. At this time, pressure is applied by both press sections and the top felt band drive is shifted from point *Y* to point *X*. Mandrel 4 begins to pick up the new sheet as the remaining sheet between the press sections is rolled onto Mandrel 1.

Sequence 6. As a pipe is being formed on Mandrel 4, Press Section 2 is raised to allow Mandrels 1 and 2 to move out of the machine. Mandrel 3 then moves to a position at the front of the forward feed rails, ready to be loaded under Press Section 2. In subsequent machine cycling, the steps beginning with Sequence 2 are repeated.

ing large amounts of bulk materials. The extent of mechanization of these functions is such that virtually no manual handling is involved. Instead, ingredients are transported by a system of belts, chutes, and pneumatic conveyors from receiving points, through intermediate processes, to automatic weighing and mixing equipment where final batches are prepared.

One of the ingredients—silica—is prepared from sand in a special grinding building at the plant, *Fig.* 1. There, sand from incoming trucks and railroad cars is dumped into a receiving bin. From the bin, the sand is fed to a bucket elevator supplying a surge tank. Discharge from the surge tank is to a gas-heated dryer which automatically deposits dry sand in a 200-ton storage hopper.

From dry storage the sand feeds out to a ball mill where it is ground into silex, a finely divided silica material. Finished silex is then conveyed pneumatically to a classifier screen where the proper production size is accepted and fed to a 200-ton storage bin. From this bin, the silex is conveyed pneumatically to two 80-ton process storage bins to await movement into production.

Cement arriving either by hopper truck or railway hopper car is unloaded by gravity into bins. From these temporary storage areas the cement is conveyed pneumatically into four 80-ton process storage tanks.

Asbestos fiber in various grades obtained from Canada, Africa, and Australia arrives at the plant in freight cars and is moved to storage by fork lift trucks. When required, the fiber is moved to a processing area where it is weighed, blended, and willowed. In willowing the blended asbestos fiber is fluffed and mixed thoroughly. From the willow, the fiber is transported pneumatically to production storage bins.

▶ Pipe Forming

Two pipe forming lines—one for production of pipes 10 feet long and the other for sections 13 feet long—are installed in the plant. Each line includes facilities such as those illustrated in the flow diagram, *Fig.* 2. In operation, prepared raw materials are drawn from the storage tanks, weighed, and mixed to form a wet asbestos-cement-silex mixture. The mixture is then fed to a tank at the input end of a pipe forming machine, *Fig. 3a*.

In the continuous pipe forming machine the wet mixture in the tank, in the form of a slurry, is transferred by a revolving drum onto an endless felt band. The material on the band is carried over vacuum chambers which remove excess moisture, and the resulting continuous sheet is carried beneath a pair of press sections. To form a pipe, one of the press sections is actuated. This places a steel mandrel in position over the sheet and lowers the press section onto the mandrel. As the mandrel rotates, the sheet builds up on the mandrel and a pipe is formed.

With two press sections to a machine, pipes can be formed rapidly. This is accomplished by forming successive pipes in alternate press sections, *Fig. 3b*. Each press section may be set up for a different size pipe, or pipes of the same size may be produced in both press sections.

Mandrels and pipes discharged from the pipe forming machine next move to a calendering station and then to an electrolytic loosener. In the loosener, a direct electrical current is passed between the outside of each pipe and its mandrel by means of a line of conducting rollers that contact the outside diameter of the pipe along its length. The mandrel is grounded during this operation. Resulting flow of high-amperage current through the pipe wall

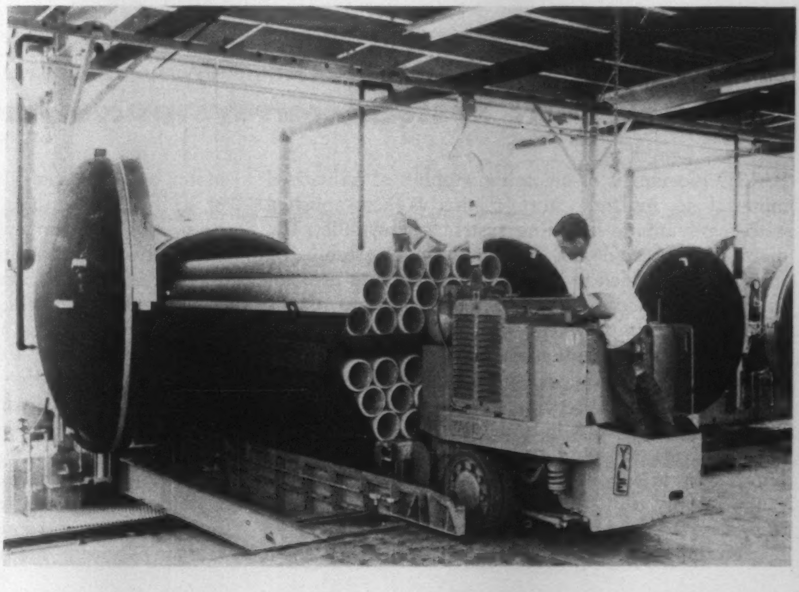


Fig. 4—After a short period for air curing, pipes and curing trays are placed in steam curing tanks. Chemical changes that occur under action of high pressure steam improve the strength and corrosion resistance of the products.

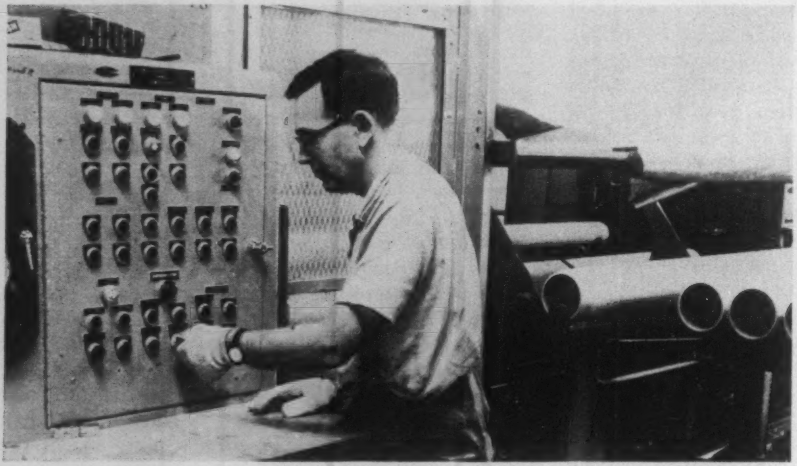


Fig. 5—Finish-machined pipes are tested at 3½ times normal working pressure in this hydrostatic test machine. Operator is shown initiating an automatic test sequence for 6-inch diameter, 150 pound pressure pipe. Other inspection routines include visual and dimensional checking before pipes are stored for final curing and shipping.

loosens the pipe from its mandrel without causing excessive temperature rise or distortion of the pipe.

Mandrels and loosened pipes pass, still assembled, through a moist heat oven and then to a mandrel extractor where the pipes and mandrels are separated. Mandrels are returned to the pipe forming machine on a conveyor, and the pipes are stacked in curing trays.

▶ Curing and Finishing

After the pipes in the trays have undergone a short air curing period, the pipes and trays are placed in steam curing tanks, *Fig.* 4. Under action of high pressure steam, the silica in the pipes unites chemically with the free lime in the cement and converts it into stable calcium silicates. This action improves the strength and corrosion resistance of the pipes.

From steam curing, the pipes are moved to a finishing area where the pipe ends are machined for fittings. In this operation, automatic lathes are used. Following machining, the pipes are moved to a hydrostatic test stand, *Fig.* 5, where they are subjected to test pressures equal to 3½ times their working pressures. After visual and dimensional inspection operations have been performed on them, the pipes are moved to an outdoor storage area for further air curing and shipping.

Capacity of the plant is 48,000 tons of asbestos-cement pipe per year. Pipes range in size from 2-inch diameter by 10-feet long, weighing about ten pounds, to 16-inch diameter by 13 feet long, weighing about 1100 pounds each. With the production methods employed in the new plant, output is about 30 per cent higher than that attainable with previous methods. Product quality and uniformity have also been improved substantially, and ordering intervals shortened for customers in the southwestern states served by the plant.

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pneumatic system conveys pulverized material

RAPID movement of incoming supplies of pulverized material to multiple storage bins is accomplished with a pneumatic handling system at the Joliet, Ill., plant of Ruberoid Co. The material, a stabilizing ingredient, is added to hot asphalt compound used for coating saturated roofing felt. The purpose of the stabilizer is to improve the weathering characteristics of roofing shingles made from the felt.

Pulverized material is supplied to the plant in 17-ton hydraulic lift trucks. When a load is delivered, an operator pushes a button which raises the cover of a receiving bin, and the load is dumped into the bin. From this point, handling operations proceed automatically until the material has been discharged to process bins and a storage silo.

Material in the receiving bin is removed by a motor-operated rotary unit and placed in the hopper of a fluidizing pump which conveys it under low pressure. The conveying route includes a vertical rise of over 50 feet followed by a horizontal run to the three process bins. Low and high process bin level controls continuously sense the quantities of material in the bins and transmit signals to a central control panel. On the basis of these signals, the control panel directs the operation of the fluidizing pump motor, diverting valves, and silo conveyor.

Advantages of the pneumatic handling system, built by Fuller Co., include reduced unloading times over former methods and dust-free operation. Installation was made without altering the plant layout. The existing receiving hopper, process bins, and storage silo were retained.

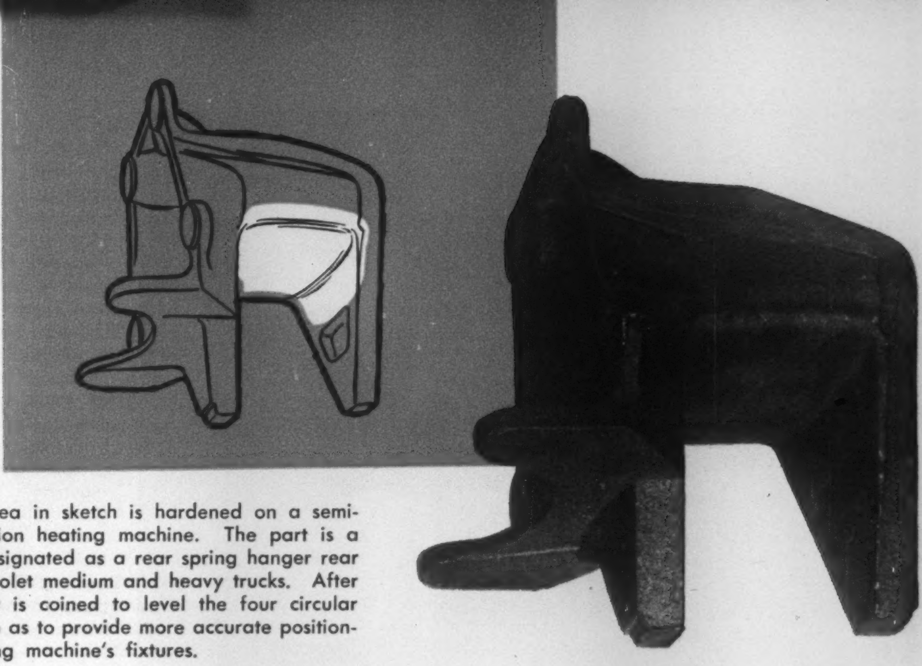


Fig. 1—White area in sketch is hardened on a semiautomatic induction heating machine. The part is a rough casting designated as a rear spring hanger rear for use on Chevrolet medium and heavy trucks. After casting, the part is coined to level the four circular mounting pads so as to provide more accurate positioning in the heating machine's fixtures.

FLOATING FIXTURES POSITION CASTINGS

IN INDUCTION HARDENING SYSTEM

Heat treating of rough castings poses many problems that make it a difficult operation to integrate into other manufacturing operations. This case study shows how one manufacturer approached the problem of hardening spring hanger castings so that all finishing operations could be performed in a single manufacturing area.

By W. E. BENNINGHOFF, Vice President, The Ohio Crankshaft Co., General Manager, TOCCO Div., Cleveland, Ohio

IN ENGINEERING, the possible jobs take time to accomplish—and the impossible jobs take just a little more time. Many engineers relish tackling the impossible jobs—especially when others have stated that they couldn't be done—for professional competence increases in stature when a production line machine has been designed and built to do an impossible job. A case in point is the development of a machine to induction harden a wearing face on cast iron rear spring hangers for Chevrolet medium and heavy trucks.

The part in question is shown in rough casting form in *Fig.* 1 with the area to be hardened indicated in white. Hardening this area by using an open flame would have been a relatively easy engineering task. However, the eventual user of the new equipment, Chevrolet Cleveland Div., General Motors Corp., intended to install the machine directly in a manu-

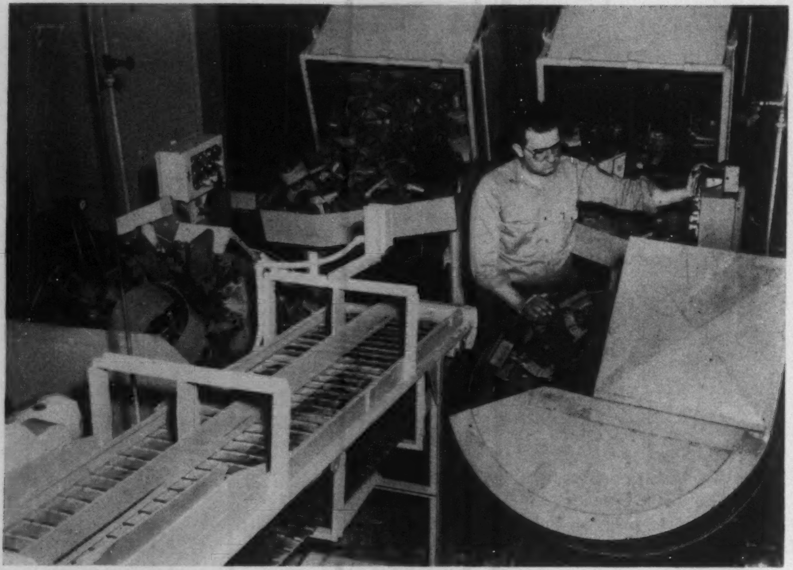


Fig. 2—The spring hanger castings are made as righthand and lefthand parts. Therefore, two hardening machines were necessary to handle both configurations. The induction heating machine on the right processes righthand parts and rotates clockwise. The machine on the left hardens the lefthand parts and rotates counterclockwise. Other than direction of table rotation, the machines are identical. One operator tends both machines, and output is approximately 50 parts per hour per machine. After hardening, the parts are kept separated and loaded onto the slat conveyor leading to a furnace drawing operation. The operator wears hand pads to protect his hands from the rough castings.

facturing area and did not want to use for safety reasons open flame methods. If possible, the user wanted the job to be accomplished electrically.

However, the configuration of the wearing face on the spring hanger caused many experts to say that the hardening operation could not be accomplished satisfactorily by induction heating methods for the following reasons:

1. The part is a rough casting which is cast to the usual plus or minus 0.045-inch foundry tolerances. For the induction heating unit to scan consistently, the machine would have to be designed so that these tolerances could be accommodated and still maintain an 0.080-inch gap between the scanning head and the heated surface.

2. The scanning head would have to be precisely located in the U-shaped opening of the part which is 3.09-inches plus 0.060 minus 0.000 wide. In addition to the bottom of the U-shape, it was desired to also harden an area one inch high on each sidewall of the U-shape. This included the fillets between the bottom and the sidewalls which are difficult to heat uniformly by an induction scanning head.

3. The bottom of the U-shape is a contoured shape which is composed of four tangential arcs. From one side of the bottom to the other, the radii of these arcs are approximately ⅜ inch, 14 inches, 2½ inches, and ½ inch.

4. Sharp corners on the part could cause localized overheating so such corners would have to be rounded if the job was done electrically.

5. Since the part is a rough casting, the absence of consistent locating points on the part, such as a machined surface, would induce difficulty in getting uniformity of heating from part to part and from one casting lot to another.

6. The part is cast from pearlitic malleable iron, and a hardening depth of 0.090 inch was desired in the bottom and the sidewalls. A minimum hardness of Rockwell C-50 was specified. This hardness would be drawn back to a lower hardness number in a subsequent operation. The hardening equipment would have to be capable of handling both a righthand and a lefthand configuration of the part.

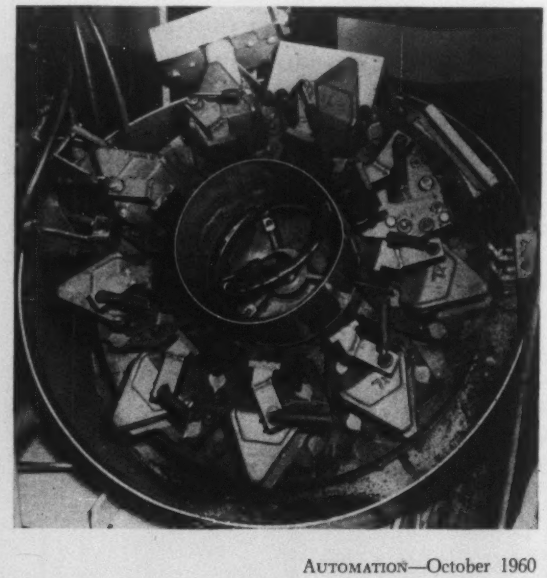


Fig. 3—This view shows the table and fixtures for the lefthand machine. The empty fixture in the upper righthand corner is at the loading-unloading position of the machine. The second fixture in a counterclockwise direction is moving a part through the horizontal alignment device. The third fixture is moving a part past the contrarotating arms of the vertical alignment device. Between the fourth and fifth fixtures can be seen the induction scanning and quenching head. On the right side of the table is the bank of limit switches which controls the operations at the various stations. These limit switches are actuated by the triangular shaped cams sticking out below the table top.

One of the companies approached to design and build an induction heating machine for these parts was the TOCCO Div., The Ohio Crankshaft Co. There, one of the few positive voices was raised that the hardening job could be done by induction heating methods, and this company was awarded a contract to develop and build an induction heating machine.

After months of development, design, building, and debugging, a highly satisfactory induction hardening system was completed and is shown installed in the user's plant in *Fig.* 2. The system is composed of two separate machines, each identical except that one rotates clockwise for hardening righthand rear spring hangers, and the other rotates counterclockwise for lefthand parts. Each machine consists basically of a rotating table on which are mounted 9 fixtures for holding parts as they pass through positioning, heating, and cooling stations. The table and fixture assembly for the lefthand machine is shown in *Fig.* 3.

▶ Three Problems

Development of a satisfactory induction heating machine hinged on solving three main problems. These problems consisted of: 1. Accurately positioning the part in the fixture so that an 0.080-inch gap is consistently maintained between stationary induction scanning head and the moving bottom surface of the U-shaped opening in the part. 2. Accurately positioning the part in the fixture so that the sides of the scanning head are always equidistant from the sidewalls of the U-shaped opening. 3. Since the bottom of the U-shaped opening is contoured and formed from 4 varying radii arcs, the 0.080-inch gap could be maintained only in relation to the longest or 14-inch radius arc. Therefore, the last problem was to compensate for an increasing air gap when the scanning head reached the shorter radii arcs, particularly the one formed by the $2\frac{1}{2}$-inch radius.

The first problem was solved by clamping the part in a fixture as the contoured face was being pressed against a set of eight locating rollers. The point of contact between each roller and the part face is on an arc whose radius is exactly 14 inches and whose centerpoint is the axis of the revolving table. When the machine is in operation, the fixture table is continually revolving. The machine operator picks up a part from a storage bin and places the hanger into the fixture between four locating pins. The back of the part is pressed against a spring-actuated plunger, and four pads on the part rest on similar pads in the fixture. During this time, the table revolves the part into contact with the locating rollers. The operator presses the part against the rollers and clamps it securely in the fixture by screwing down an overhead locking clamp. A view of the part as it moves through this station is shown in *Fig.* 4.

The second problem was how to accurately position the part in the fixture so that the sides of the scanning head are always equidistant from the sidewalls of the U-shaped opening. This positioning action is accomplished by a pneumatically operated, X-type contrarotating device, *Fig.* 5, located immediately following the locating rollers. Each fixture of the machine is mounted on the rod of a double-acting hydraulic cylinder, and all nine cylinders are located under and perpendicular to the table top.

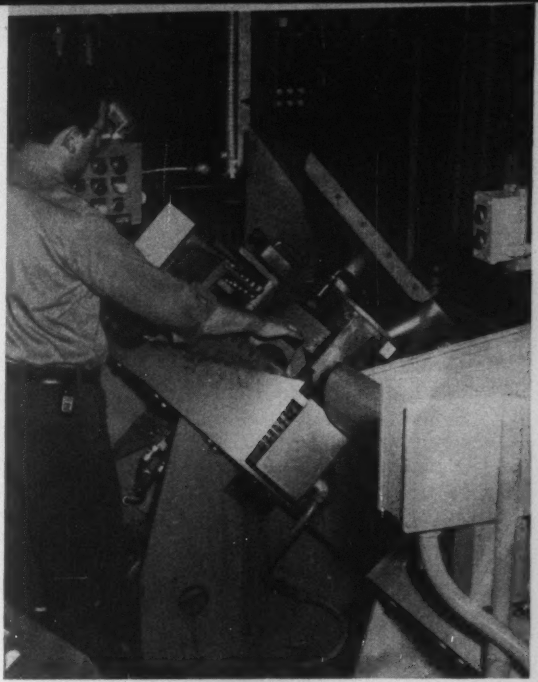


Fig. 4—Immediately above the operator's arm in this view can be seen the locating rollers for positioning the part in a horizontal plane. A spring-actuated plunger forces the contoured surface which is to be hardened against the eight rollers, and the operator then clamps the part tight. This alignment is necessary so that a constant gap is maintained between the scanning head and the part face. Below the operator's hand and through the slot in the machine side can be seen the seven cam bar rings.

As the table rotates the part to the vertical positioning device, the X-type arms of the device move into the U-shaped opening of the part. At the same time the roller of the hydraulic valve rides up on a stationary cam, opening the valve so that hydraulic fluid is free to flow between the two ends of the cylinder. As the table continues to rotate, a cam-operated limit switch energizes a solenoid-operated pneumatic valve which admits air to the rod end of a double-acting pneumatic cylinder. This action causes the piston to move toward the blind end of the cylinder. The two contrarotating arms, which are in the U-shaped opening of the part, are connected to the free-floating cylinder. One arm is connected through a shaft and lever arm to the blind end of the cylinder, and the other arm is connected through a sleeve shaft and lever to the rod end. Both arms are pivoted on a horizontal axis which is in the same plane as the horizontal centerline axis of the induction scanning head.

As the contrarotating arms open up and engage the part, the part is positioned. As the table continues to rotate, the roller of the hydraulic valve rides off the stationary cam, closing the valve and trapping hydraulic fluid in each end of the fixture positioning cylinder. This action positively holds the fixture and part in its proper relationship with the centerline of the induction scanning head.

Any hydraulic fluid losses are replenished by an air-loaded hydraulic accumulator which is mounted in the hollow spindle of the rotating table and can be removed for refilling. Normal working pressure maintained in the accumulator is approximately 50 psi air. A charging and gaging assembly is provided for checking the air pressure of the machine and to add air when the pressure drops to 25 psi.

Immediately prior to reaching the induction heating station, the part is checked electrically to see that it has been properly positioned. This is accomplished by a ground detector which consists of a vertical plate, slightly smaller than the U-shaped opening, that is connected to a low voltage alarm circuit. If any face of the opening touches this ground detector, the secondary winding of an isolation transformer is shorted, decreasing the inductive reactance in the primary winding of the transformer and causing a relay coil to actuate. The contacts of this relay close, illuminating a white light and stopping the table. If there is a part in the heat cycle, the table will continue moving until the part is past the scanning head. The operator can remove the improperly positioned part by pressing a *Reverse* pushbutton which causes the table to reverse and move the part out of the ground detector. After the operator removes the part, he can press a *Reset* button to start the machine again.

▶ Induction Heating

The third problem which had to be solved was how to compensate for an increasing air gap as

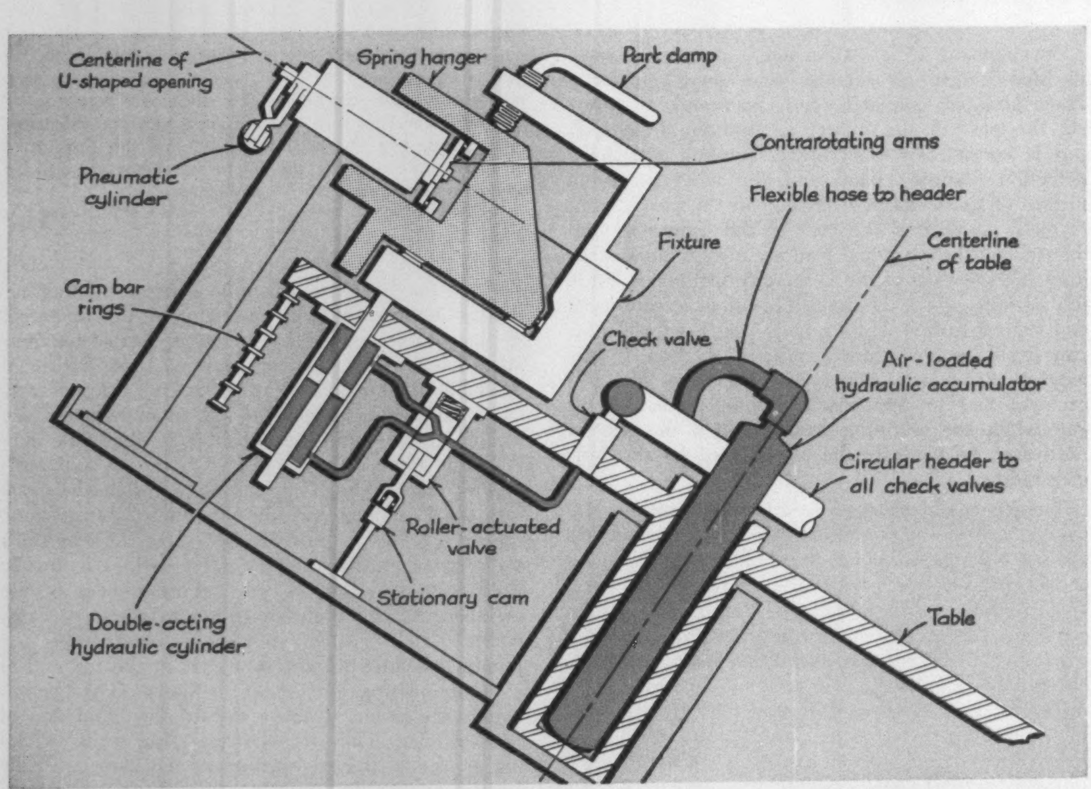

Centerline of U-shaped opening
Spring hanger
Part clamp
Contrarotating arms
Pneumatic cylinder
Flexible hose to header
Fixture
Centerline of table
Cam bar rings
Check valve
Air-loaded hydraulic accumulator
Circular header to all check valves
Roller-actuated valve
Stationary cam
Double-acting hydraulic cylinder
Table

Fig. 5—This sketch shows the method of positioning the part vertically. The part is clamped tightly in the fixture which is affixed to one rod of a double-acting hydraulic cylinder. As the table rotates, the stationary cam causes the roller-actuated valve to open, allowing free movement of hydraulic oil between the two ends of the cylinder and an air-loaded hydraulic accumulator. At the same time, a cam attached to a cam bar ring actuates a limit switch, admitting air to the pneumatic cylinder. This action causes the contrarotating arms to open against the sidewalls of the U-shaped opening in the part, moving the part and fixture vertically until the centerline of the U-shaped opening is on the same horizontal axis as the contrarotating arms. The roller of the hydraulic valve then rides off the stationary cam, causing the valve to close, and the trapped hydraulic fluid locks the fixture into position. The pneumatic cylinder closes the contrarotating arms, leaving the part positioned so that it is centered when it passes the induction scanning head at the next station.

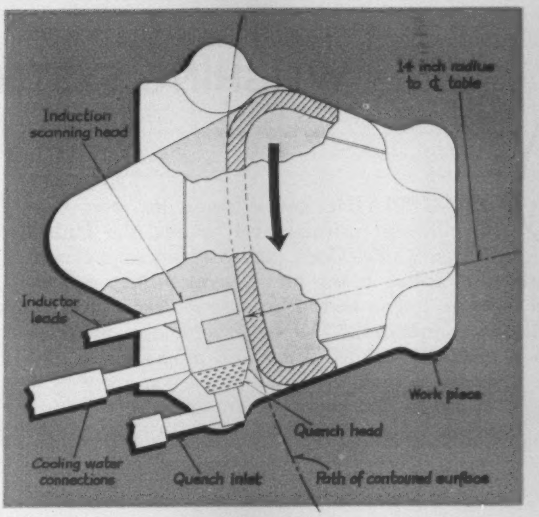


Fig. 6—The relationship of the induction scanning head to the part face is shown in this sketch. The scanning head is stationary, and the table moves the part as indicated. The inductor heats the contoured bottom and approximately one inch up the sidewalls of the U-shaped opening of the part. After the part is heated to temperature, it is automatically quenched with a soluble oil and water solution.

the induction scanning head moved past the short radii arcs. The machine is designed to maintain an 0.080-inch gap when the head is heating the longest arc whose radius is 14 inches. It was decided to compensate for gaps greater than 0.080 inch by providing means for automatically changing the rotational speed of the fixture table. Therefore, each machine table is driven by a dc gear reducer motor which is controlled by a General Electric Co. amplifier-type rotating exciter. Four potentiometer controls provide for setting up as many as four different speeds for each table.

In actual practice it was found that only two different speeds were necessary for satisfactory heat treating. Each table is rotated at normal speed during the time the scanning head is heating the 14-inch radius arc. Then, when the $2\frac{1}{2}$-inch radius arc is reached, a cam-actuated limit switch energizes relays to cause the motor control to reduce the table speed. As soon as this arc is cleared, the machine reverts to normal table speed.

A sketch of the water-cooled induction scanning head is shown in *Fig.* 6. A 100-kilowatt, 10-kilocycle motor-generator set provides the two scanning heads (one on each machine) with power for the hardening operations. Each head uses a cooling rate flow of about 2 gallons per minute of water which picks up an approximate 35 F temperature rise between inlet and outlet. Immediately following the heating operation the part is quenched in a $\frac{1}{2}$ per cent soluble oil in water solution.

After heating and quenching, the table revolves the part through five cooling stations to the unloading station. At this point the part is cool enough to be removed without gloves. The operator, who attends both the righthand and the lefthand induction heating machines, unclamps the part and places it on a slat conveyor for transport through a draw furnace. A dividing strip located in the center of the conveyor keeps the two different types of parts segregated. In the draw operation, the parts are heated to a temperature of about 375 F in the electrically heated furnace built by Industrial Heating Equipment Co.

After about $1\frac{1}{4}$ hours, the parts leave the oven and enter a water cooling bath. Still segregated from each other, the righthand and lefthand parts are lifted out of the bath and dumped onto a slanted storage table. From here, an operator loads the parts on a Kingsbury Machine Tool Corp. automatic drilling and tapping machine where six mounting holes are drilled, the two inline spring pin retainer holes are drilled, and a single hole is drilled and tapped. After these operations, the parts are finished and ready to be installed on trucks.

▶ Station Control

The various actions of the induction heating machines are controlled by adjustable cams located on the underside of each table. Each machine has a stack of seven cam bar rings which are mounted under the perimeter of each table and can be partially seen in *Fig.* 4. The cams are wedge shaped and are clamped on the rings by setscrews. Near the load-unload station is a bank of seven limit switches (see *Fig.* 3) which are contacted by the various cams to initiate operations.

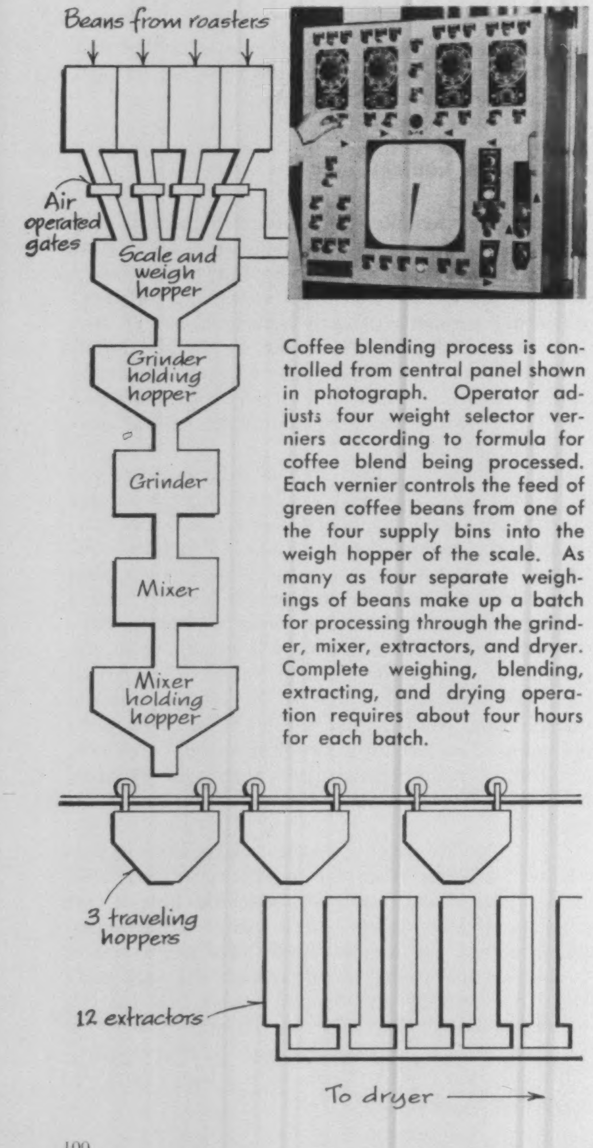
The actions controlled by the limit switches are as follows: One energizes a solenoid-operated valve to admit air to the pneumatic cylinder at the contra-rotating positioning device. A second energizes a relay which applies current to the induction scanning head when a part is in position for heating, and a third de-energizes the relay when the parts leave the scanning head. A fourth was originally in the circuit to activate the quench system. This circuit has been replaced by an *On-Off* switch, and the quench runs continuously while the machine is in operation. The last three switches energize the various control potentiometers for varying the speed of the table. However, only two speeds are used on the table.

The induction heating machines have been in successful operation since the beginning of the 1960 model year. Output of each machine unit is approximately 50 parts per hour. The main advantage of the semiautomatic production system is that no machining is required on the part other than the drilling and tapping operations for the mounting holes. The only other operation done on the hangers is a press coining prior to heat treating. This operation levels the mounting bosses with respect to each other.

WEIGHING SYSTEM BLENDS COFFEE

IN SUPPLYING coffee blends for more than 50 different private label brands, the United Instant Coffee Corp. each year processes various grades of coffee beans into several million pounds of soluble coffee and coffee concentrates. Key to efficient handling of this large volume of materials is a recently installed automatic proportioning system which is used to select, proportion by weight, and deliver coffee beans to an extraction process.

Imported green coffee beans are received at the plant in bags. After cleaning and sorting by air and mechanical means, the beans are deposited in storage hoppers until needed. Each storage hopper holds a particular type and grade of coffee bean. When a particular blend of coffee is to be run, the beans to be used in the blend are withdrawn from storage and delivered to roasters. After a 17 to 25 minute roasting time, the beans are conveyed pneumatically to four supply bins at an upper level of the plant.



Coffee blending process is controlled from central panel shown in photograph. Operator adjusts four weight selector verniers according to formula for coffee blend being processed. Each vernier controls the feed of green coffee beans from one of the four supply bins into the weigh hopper of the scale. As many as four separate weighings of beans make up a batch for processing through the grinder, mixer, extractors, and dryer. Complete weighing, blending, extracting, and drying operation requires about four hours for each batch.

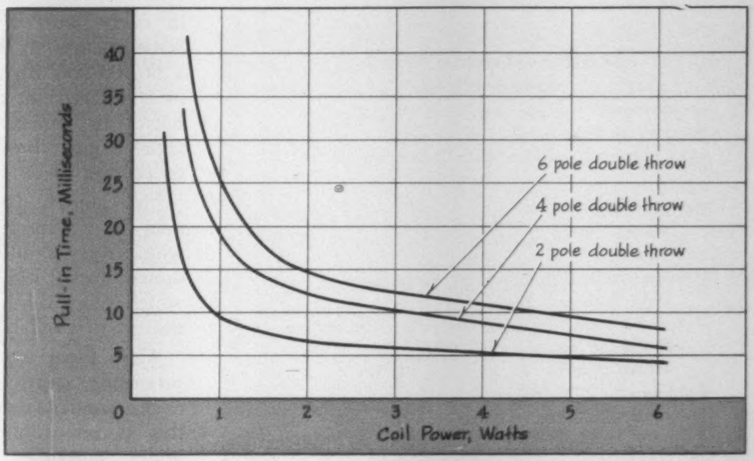
From this point forward, an automatic proportioning system provided by Richardson Scale Co. controls the weighing, grinding, mixing, and in-process storage of the beans until the blend is ready to enter the extractors. The beans are ground and mixed in batch loads which weigh up to 1600 pounds each. Each batch load may be composed of four separate weighings of beans which are drawn from the supply bins in quantities varying from one to 400 pounds. Discharge of beans from the supply bins is controlled from a central control panel where the weight required from each bin is manually set with four weight selector verniers.

The system operates as follows. An operator sets the control panel weight selector verniers to the proper weights as called for in the blend formula. In accordance with the setting of the first vernier, roasted beans are released from a supply bin and fed into a weigh hopper of a bulk weighing scale. When the proper weight is reached, the feed is cut off, and the weigh hopper discharges into a grinder holding hopper. Before the next ingredient is released, a tare check is made on the system. The weigh hopper door then closes. The second weight selector vernier for the next ingredient then feeds its preset weight of coffee beans into the weigh hopper. The cycle continues until as many as four weighings are discharged into the grinder holding hopper. At this point in the sequence the scale stops.

While this batch is being weighed, a previous batch is being ground and mixed. As the previous batch is discharged into a mixer holding hopper, the weighed batch is discharged from the grinder holding hopper into the grinder, and the scale starts weighing beans for the next batch. Each batch is thoroughly ground and mixed so that all the types and grades of beans in the formula are fully blended. When a preset time expires, the mixer automatically discharges the blend into the mixer holding hopper.

Three manually operated hoppers mounted on overhead tracks receive the blend from the mixer holding hopper. Moving laterally above a line of 12 upright extractors, the hoppers deliver the blends to the extractors. After a liquid base has been extracted from the blend, it is piped to the top of the plant where the base is sprayed into a large dryer. Hot air jets evaporate the moisture from the base to form the dried soluble solids of an instant coffee.

Fig. 1—Chart shows several operating time curves for Potter & Brumfield TS series small telephone type relays having 340-ohm coils. At, or near the pull-in point of the relay, minor changes in the power input will make substantial changes in the operate time of the relay.



USING RELAY CONTROL EFFECTIVELY

Relays are the workhorse control elements of automatic systems. How do you insure good relay control, select the proper style or type, and obtain suitable system operation and reliability for automation? This presentation sets up some fundamental rules and considerations to observe.

By ZEKE SMITH
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American Machine & Foundry Co., Princeton, Ind.

A RELAY is an electromechanical device which is operated by variation in the conditions of one electric circuit, to affect the operation of other devices in the same, or other electric circuits, by either opening contacts, or closing contacts, or both. This definition of a relay as suggested by the National Association of Relay Manufacturers epitomizes the main problems associated with the effective use of relays. It is accurate, all inclusive, and quite vague. Effective use of relays and relay control requires accurate, all inclusive, and quite specific—not vague—information being passed from the relay user to the relay supplier and vice versa.

A relay is a switch. Its design must first be directed toward assuring proper operation of its contacts. Suitable contact performance requires adequate contact force, motion, mounting, and actuation. Providing these mechanical conditions imposes requirements on the motor element used to actuate the contacts, and these requirements in turn control the motor's design.

▶ Relay Components

It may be said that a relay consists of two complete systems—a contact system and an actuator system. These two systems are modified by the physical requirements of the completed device, by the environmental conditions under which the complete relay must operate, and by any supplementary requirements such as military specifications, Underwriters' requirements, or JIC specifications.

Basically, relay contacts act as a circuit component having a resistance with two extreme values. These values correspond to the open and closed contact conditions where the closed condition is a low resistance value, usually less than one ohm, and the open condition is a high value in the order

7

TABLE 1—Contact System Specifications

ARRANGEMENT
Number of Poles ....
Single-throw, Double-throw, Otherwise ....

LOADS
Current: Make ....ac-dc
  Steady State ....ac-dc
  Break ....ac-dc
Voltage: Open Circuit ......Frequency ....
  High Potential Test ....
Nature of Load: Resistive, Inductive, Capacitive .
  Motor or Lamp ....
  Power Factor ....L/R ....
Frequency of Operation ....
Minimum Number of Operations Required ......

PROTECTION
RC Circuits, Diodes, Rectifiers, Thermistors ......

of megohms. To meet these requirements, contacts must be held closed with some minimum force and must be separated by some minimum spacing when open.

These two conditions must be maintained constant when the contacts are at rest. The transfer from one condition to the other should be as abrupt and free from oscillation as possible. The contacts of every relay must satisfy these conditions, and any departure represents either the end of the useful life of the relay or defective performance of the system in which it is working. Contact failure may be said to occur when either the closed resistance is too high or the open resistance is too low.

The actuator system is essentially a motor. This is a device that takes the electrical energy supplied to the input of the relay and produces the mechanical energy to transfer the contact system. The actuator system, or motor, may be said to have failed when the minimum specified power input fails to produce the mechanical energy necessary to transfer the contact system. Failure of either the contact system or the actuator system leads to ineffective relay control.

It might appear that using relay control effectively should be no problem at all, since the major item—a relay—consists essentially of two simple systems which are modified by three groups of well defined parameters. Not so! This faulty concept is the greatest single stumbling block to the proper use of relays, and, in turn, the effective use of relay control. These so-called simple systems have grown to the point that it takes several pages of fine print in a buyer's guide to list the standard types of relays, not to mention an almost infinite variety available having minor modifications of these so-called standard types.

Many engineers, engineering designers, and users of relays ask the question: "What will the relay do?". Except in the broadest of terms no one knows. No relay has ever reached its ultimate possibilities in every facet of its potential at any one time. Some operate on microamperes, others operate when a 66,000-volt highline short circuits. Some operate in a millisecond, others require hours. Some switch microvolts, others switch hundreds of thousands of volts. Known limitations include only speed, sensitivity, and cost.

First step in using relay control effectively consists of determining what the relay is to do—not which relay shall be used. Once it has been determined, then, and only then, is it time to consider which relay shall be used, preferably with the assistance of a reliable relay supplier.

After these two steps have been taken, tests of promising relays should be made in a prototype device under actual operating conditions. When this is impossible, tests in the actual equipment under carefully simulated operating conditions should be required to determine that the proposed relay is adequate. There is no substitute for testing a promising relay in the specific job under actual operating conditions. When all three steps have been taken, we are well on the way to using relay control effectively.

To assist in determining what the relay is to do, a series of tables are shown which cover the contact system, the actuator system, physical requirements, environmental conditions, and supplementary specifications.

▶ Selecting Contacts

The contact arrangement refers to the combination of the different basic contact forms used to make up the entire relay switching structure. This informs the relay supplier what number of poles is desired; whether the poles are to be single-throw, double-throw, or otherwise; and whether they are to be normally-open or normally-closed, TABLE 1. The maximum number of poles which any relay is capable of handling is determined in the inherent design and is limited by the total amount of power available from the motor structure for operating the contact forms. All relays will handle at least one pole, but very few will handle 6, 8, 10, or more. Therefore, the contact arrangement will have a very decided influence on which relay structure the relay supplier will suggest.

Once the contact arrangement has been determined, it becomes necessary to detail completely the load each contact is expected to make and break. Fundamentally, the life of any relay contact is determined by the amount of electrical energy the contact is required to handle upon make, and the amount of energy it is necessary for the contact to dissipate during the break condition. The current, voltage, nature of the load, duty cycle, and frequency of operations influence the amount of energy handled, and thus influence the minimum number of operations the relay can be expected to survive.

The nature of the load is extremely important and frequently is totally ignored when specifying contact loads. If the load is resistive, the amount of energy is easily defined by determining the open circuit voltage and the resistance. However, if the load is inductive, the contacts, upon breaking, may be required to absorb a large amount of energy stored in the inductive field. Unless the inductance and either the ratio of inductance to resistance or power factor is specified, the relay supplier has no idea of the magnitude of the problem before him. If it is a capacitive load, the current inrush will be much higher than the steady state current, depending upon the size of the capacitor. Single phase motor loads are particularly difficult since they have an excessively high inrush on contact make, and are highly inductive upon the contact break condition.

Many circuit designers overlook the fact that switching a lamp load can be extremely hard on relay contacts. The ratio of hot to cold filament resistance is about 10 to 1. This means that the contacts used to close the circuit to a cold filament are required to handle an initial current 10 times the steady state current value existing after the filament reaches operating temperature. More than one designer is disturbed that a 2-ampere contact does not give satisfactory performance on a 200-watt, 115-volt lamp load. The reason becomes quite apparent once it is realized that the initial starting current is in the order of 20 amperes every time the lamp is energized from a cold condition.

The frequency of operation of the contacts becomes important at either extreme. If the frequency of operation is extremely high, a contact could have a very short life due to high heat generated by arcing during rapid switching. The same contact might be entirely adequate if the frequency of operation were lower, and the contacts would have time to cool following each make and break.

On the other hand, contacts which operate very rarely, such as those in a safety circuit, should be those having the greatest resistance to tarnishing; thus giving reasonable assurance against possible failure due to film contamination. Gold contacts, for instance, might be the best possible choice for a safety circuit which operates rarely. Yet, gold may be a very poor choice for contacts operated frequently.

TABLE 2—Actuator System Requirements

TYPE OF POWER SOURCE

Power line ac or dc ....
Rectified ac or pulsating dc ....
Storage Battery or Dry Battery ....
Plate Circuit of Vacuum Tube ....
Transistor ....

LOAD REQUIREMENTS

Nominal Voltage or Current ....
Maximum Voltage or Current ....
Pull-in (Pick-up Value) (Operate Value) Tolerance
Drop-out Voltage ....Tolerance ....
Nonoperate Value ....
Differential ....
Operate Time ......Maximum......Minimum...
Release Time ......Maximum......Minimum...
Coil Resistance ....Tolerance...
Duty Cycle ....

Another factor of major importance in connection with the contact system is the need for indicating as conscientiously as possible the minimum acceptable number of trouble-free operations as a projected life requirement. For example, a relay which operates only once a day, such as in a street lighting application, switches its load only about 365 times a year. A projected 10-year life requirement would indicate the need for less than 4000 operations. Some specifications on relays of this type call for life requirements as high as 100,000 operations. These requirements are unrealistic and can only make the relay designer's problem unnecessarily complicated.

Conversely, relays are frequently required to operate millions of times. In this case, the need for a realistic statement of load requirements is necessary. This leads to the last, but by no means least, bit of information needed concerning the contact system: Will contact protection be used? In any extremely long life application, serious consideration should be given to some form of contact protection, such as a resistance-capacitance circuit, rectifiers, or thermistors. Many seemingly impossible life requirements become realistic when suitable contact protection is incorporated in the completed equipment. It is also somewhat frustrating for the relay designer to have a request for 100 million operations at 3 ampere inductive load, 48 volt dc, on a multicontact telephone-type relay and not be told that the equipment designer intends to use suitable contact protection.

▶ Specifying Contact Actuators

The contact actuator system is essentially a motor. This is a device that takes the electrical energy supplied to the input of the relay and produces the mechanical energy to transfer the contact system, thereby enabling the circuit switching to take place. As might be expected, the first information the designer of the relay needs is the type of power source that will be available to operate the relay motor. Will it be an ac or dc power line, a storage battery, dry battery, or some other source?

Rarely is the relay designer told that rectified ac will be the power source. This is in essence pulsating dc. By using an adequate slug on the relay core, it is usually possible to obtain satisfactory performance without the use of condensers across the coil. However, the relay engineer must know that rectified ac is to be used to do a proper design job.

Once the type of power source has been decided. the user should specify nominal voltage or current, the maximum voltage or current, and the

TABLE 3—Physical Requirements

Maximum Permissible Dimensions ....
Mounting ....
Marking ....
Finishes ....

TERMINATIONS

Solder Terminals (Size Wire) ....
Plug-in ....
Quick-connect ....
Taper Tab ....
Printed Circuit ....

minimum voltage or current at which the relay motor is expected to operate. Other information of value includes the pull-in, drop-out, and nonoperate voltages; the differential required if any; the operating time requirements; release time requirements; coil resistance desired; and the duty cycle, TABLE 2.

Probably the greatest single inadequacy found in specifying information in this area stems from the desire of the equipment designer to be more than safe in specifying the operating points or voltage operating range. It is not unusual for a relay to be required to pull in at 18 volts dc, operate on a nominal voltage of 24 volts dc, and not burn up at 30 volts—over a temperature range of minus 65 C to plus 125 C. Voltage spreads of this breadth stem from military requirements for definite reasons. However, the same kind of thinking is frequently used in commercial applications where the requirements are not founded upon a real need but are the result of the equipment designer's belief that these are standard specifications.

Since the power dissipated in the coil increases in proportion to the square of the voltage, extremely wide operating voltage requirements require that an excessive safety factor be designed into the coil. If absolutely necessary, this can be done. But for most commercial relay requirements, this results in the relay designer obtaining less actuating force from his motor structure and makes the relay more difficult to build. Obviously, this raises the cost.

Another area which leads to a great deal of misunderstanding concerns operating and release times. The operating time of all conventional relays varies over an extremely wide range depending upon the amount of power applied to the motor. Hence, it is necessary that the relay designer know at what voltage or current the operating time will be measured.

At low levels of operating power the operating time of any given relay will vary greatly with the load which the motor must overcome and the time constant (ratio of inductance to resistance) of the coil. At maximum power levels the operating time will depend primarily upon the mass of the armature and other moving parts. At, or near the pull-in point of the relay, minor changes in the power input will make a great change percentagewise in the operate time of the relay.

The most constant timing will be obtained by operating at a power level where the mass of the moving parts are the prime factors. In any event, it is essential that the power level be specified at which the operate and release times are determined. Several typical operating time curves are shown in *Fig.* 1.

The duty cycle becomes important when the actuator system is required to operate at extreme rates. Usually, fast operating times for a given relay type may become possible if the relay is used only on intermittent duty so that abnormally high power may be applied to the coil. In other cases, a high ambient temperature condition may be satisfactory on an intermittent duty device which would be entirely impractical or very costly if the coil were to be energized continuously.

Once all of the information needed in regard to the contact and actuator systems has been completely listed in detail, attention should be given to modifying factors. These include physical requirements, environmental conditions, and any supplementary specifications.

▶ Physical Requirements

Physical requirements break down into the space available, mounting means desired, marking, finishing, and termination, TABLE 3. Generally, the type of equipment using the relay will largely dictate the general physical aspects of the relay as a component. However, apparently no designer of modern electronic equipment wants to provide more space than the absolute minimum for any component. If it is necessary for the equipment designer to place maximum limitations on the three dimensions determining the size of a relay, then he should be as generous as possible in this respect, and by all means, accurate. It may seem incredible but, many relays in present equipment are misapplied

TABLE 4—Environmental Conditions

TEMPERATURE

Maximum ....
Nominal ....
Minimum ....

HUMIDITY

Maximum ....
Nominal ....

CORROSIVE OR EXPLOSIVE ATMOSPHERES

Dust ....
Shock (Military) ....
Vibration ....
Altitude ....
Linear Acceleration ....

ENCLOSURES

Hermetically Sealed ....
Dust Cover ....

simply because the relay was designed into the equipment last, and there wasn't enough space left to get an adequate relay in the equipment.

The method of mounting the relay will depend largely on the general structure of the equipment and whether the relay is to be furnished with an enclosure, a dust cover, or a hermetically sealed container. The most common mistake made in specifying mounting information is to neglect the end-use position of the relay. Practically all relays can be mounted in any position, but mounting does affect pull-in and drop-out if the relay is in other than its anticipated position.

In some cases, it is not feasible to mount the relay in any position other than a given position because gravity is used to return the armature to its unenergized position. When this is the case, the manufacturer will note that the relay is "position sensitive." Unless the manufacturer has definitely specified that the relay is position sensitive, it is possible to compensate for any unusual mounting positions during manufacture. In any event, it is necessary that the relay supplier be forewarned.

Marking of open relays is usually limited to the manufacturer's name or trademark, part number, and occasionally the equipment manufacturer's designation. On most of the smaller relay types there is rarely room for more than this limited amount of information and seldom any need for anything else since the terminals are all exposed, and the wiring connections are quite evident. On dust covered or hermetically sealed relays, however, there is practically always a wiring diagram of the terminations together with any additional data that may be required by the equipment manufacturer. The main requirement here is that the relay supplier be notified what marking is desired.

The finishes used on the relay are generally determined by what the relay is required to do. For this reason, it is unusual and generally undesirable for the relay user to specify particular finishes on the relay. However, relays which are supplied in some sort of an enclosure can be finished almost any way the relay user desires them.

The terminations used on relays are many and varied, but unfortunately it is not possible to have all types of terminations available for all types of relays. Solder, quick-disconnect, and screw terminals cover the general types. The prime requirement here is once again referred to the user—what is needed to do the job satisfactorily.

▶ Environmental Conditions

The ability of relays to perform satisfactorily under many different environmental conditions has been brought about to a large degree by the ability of the manufacturer to hermetically seal the completed relay. Contrary to the popular belief, the complete physical protection of a relay by this means very seldom contributes to an improvement in the useful life of the relay. Generally, it has exactly the opposite effect for a hermetically sealed relay will not provide as long a life under the same load conditions as one without an enclosure of any sort. The reason for this is that the atmosphere within the relay enclosure, being confined in a small space, becomes contaminated within a relatively short time with the vaporization products of the various materials used in the construction of the relay.

TABLE 5—Supplementary Specifications

Military ....
Underwriters' Laboratories ....
JIC Standards ....

The only current exceptions to this are those relay contact structures which are hermetically sealed in a hard vacuum, or those in which the contact structures are hermetically sealed in high pressure hydrogen.

Ignoring the two above exceptions, it is safe to say that a relay should never be hermetically sealed unless the environmental conditions are such that it must be sealed to work satisfactorily. These conditions would include high altitude operation or corrosive, explosive, or extremely dusty atmospheres.

The environmental conditions which need to be specified in detail include temperature, humidity, unusual atmospheric conditions, shock, vibration, altitude, and linear acceleration, TABLE 4. Of these conditions, the operating temperature is the most frequently overlooked, and certainly the least understood.

For example, a military specification requires that a relay be capable of operating in a maximum ambient temperature of 125 C. If a 24-volt dc relay is being considered for such an application, it is necessary that this relay be capable of pulling in at 18 volts or less at the maximum operating temperature. It is not sufficient to test the relay for operation at this voltage at room temperature since the value of the coil resistance increases approximately 39 per cent as the temperature rises from ambient to 125 C. This has the effect of reducing the amount of current being passed through the winding at the 18-volt level. Since it is actually the value of this current which provides the energy to operate the relay, it becomes necessary to set up the specifications in such a manner as to guarantee that the proper current level will be provided even with the increased value of coil resistance at the highest operating temperature. This means it will be necessary to require the relay to pull-in at approximately 12 volts at room temperature in order to guarantee that it will operate at 18 volts at 125 C.

In applications where the relay is required to operate at maximum temperature shortly after it has been energized for a period of time, the allowance made for the room temperature operate value would also have to take into account the added increase of coil resistance due to the self-heating of the coil. This may bring the actual coil temperature in some cases up to 150 C or more, depending on the temperature rise of the relay.

Since the resistance of the relay winding is reduced considerably at very low temperatures, this same method of reasoning must be applied in reverse if a definite minimum drop-out voltage is established by the equipment designer. For example, if this relay is required to drop-out at 5 volts or more at a temperature of minus 65 C, it may be necessary to establish the drop-out point—when measured at room temperature—as high as 10 volts including a safety factor. Thus, we may very rapidly approach the requirement for a very close differential relay.

▶ Supplementary Specifications

The last factor which may modify a relay's actuating and switching system falls under the heading of supplementary specifications. These include the various military specifications, Underwriters' Laboratories requirements, and JIC specifications, Table 5.

Many users of relays seem to be convinced that, if they simply copy one of the military specifications, they neatly solve their own problem. Nothing could be farther from the truth. If military specifications are involved in the application, then the equipment design engineer will have very little choice but to pass on to the relay manufacturer the necessary information concerning the particular specifications with which he is concerned. However, it must be borne in mind that he also has the responsibility of designating certain detailed variations in these specifications. For instance, military specification MIL-R-5757C has three classes of temperature ranges, three types of enclosures, and three types of shock tests, plus numerous other possible variations. All of these variations need to be spelled out in detail. The same is true of any other military specification pertaining to relays.

In specifying that a relay should be capable of meeting Underwriters' Laboratories requirements, almost everyone seems to forget that this organization has many standards. While there are many similarities, their standard for motor operated appliances and their standard for industrial control equipment vary a great deal. Merely stating that a relay should meet Underwriters' requirements is not enough. The specific standard definitely should be mentioned.

Technically speaking, Underwriters' Laboratories does not approve anything. They only determine if the completed equipment is suitable for Underwriters' listing. While there are undoubtedly exceptions, in the vast majority of cases it is necessary that the completed piece of equipment receive Underwriters' Laboratories listing. The fact that a particular component, such as a relay, is listed does not necessarily mean that it is suitable for use in some particular piece of equipment. This seems to lead to many misunderstandings.

One reference to relays in the JIC Standards is in paragraph E15.1.8 and reads as follows: "Relays having a NEMA rating of 10 amp and higher with pigtail leads or shunts on contacts are not acceptable." In addition to this, I would like to quote two additional paragraphs: Paragraph E10.1—"Purpose: The purpose of these electrical standards is to provide detailed specifications for the application of electrical apparatus to industrial equipment which will promote: a. Safety to personnel. b. Uninterrupted production. c. Long life of equipment. d. Ease and low cost of maintenance. These standards are not intended to limit or inhibit the advancement in the art of electrical or mechanical engineering." Paragraph E10.4—"When purchaser requires electrical equipment and installation of such equipment by the vendor to conform to these JIC electrical standards and other requirements, he shall so specify in his original inquiry and on his purchase order."

The problem of using relay control effectively finds its shortest, simplest solution by first determining what the relay is to do; second, selecting likely, or the most promising relays for the job to be done; third, testing the relay under actual operating conditions. When these three steps have been taken, the relay control will be effective.

are you stuck?

Since its inception Automation has helped increasingly in the solutions of hundreds of widely diversified practical problems in making manufacturing operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available from reliable builders or suitable techniques are known to specialists.

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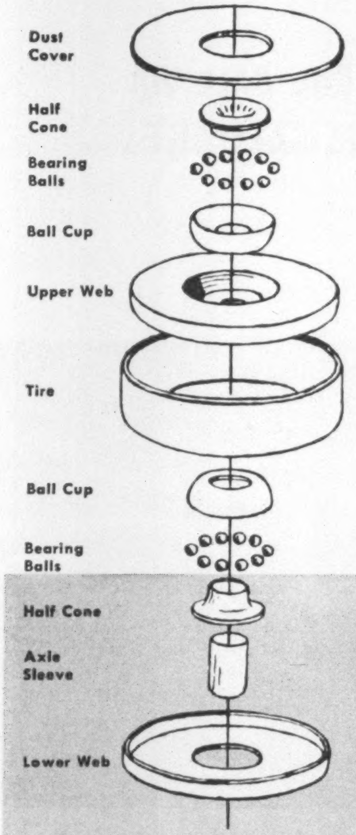
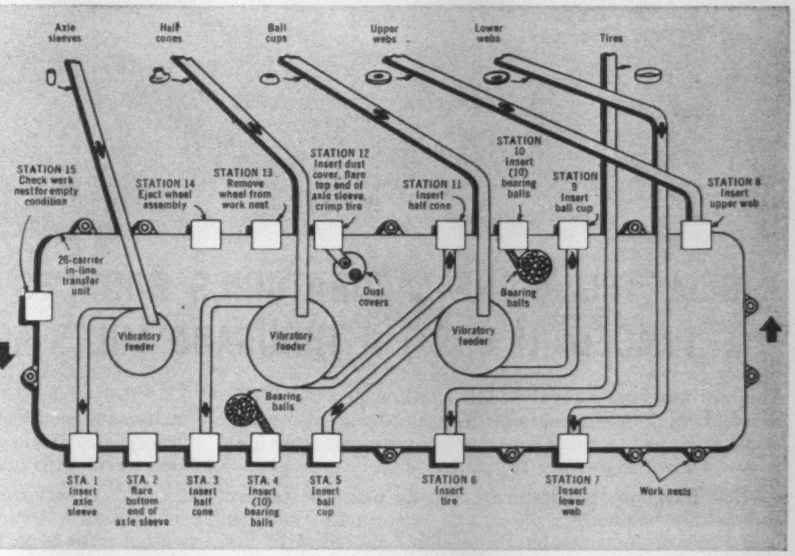

Dust Cover
Half Cone
Bearing Balls
Ball Cup
Upper Web
Tire
Ball Cup
Bearing Balls
Half Cone
Axle Sleeve
Lower Web

From MULTIPLE PARTS to FINISHED WHEEL in 2 SECONDS

In-Line Transfer Machine assembles Roller Skate Wheels

Consisting of 20 Bearing Balls and 9 Other Parts


Axle sleeves
Half cones
Ball cups
Upper webs
Lower webs
Tires
STATION 15 Check work nest for empty condition
STATION 14 Eject wheel assembly
STATION 13 Remove wheel from work nest
STATION 12 Insert dust cover, flare top end of axle sleeve, crimp tire
STATION 11 Insert half cone
STATION 10 Insert (10) bearing balls
STATION 9 Insert ball cup
STATION 8 Insert upper web
26-carrier in-line transfer unit
Dust covers
Bearing balls
Vibratory feeder
Vibratory feeder
Vibratory feeder
Bearing balls
STA. 1 Insert axle sleeve
STA. 2 flare bottom end of axle sleeve
STA. 3 Insert half cone
STA. 4 Insert (10) bearing balls
STA. 5 Insert ball cup
STATION 6 Insert tire
STATION 7 Insert lower web
Work nests

This schematic diagram illustrates general layout and direction of flow of parts for wheel assembly machine.

When two types of assemblies require basically the same components there exists an "amplification factor" which adds to the economic justification of automatic assembly. In the case of this in-line transfer machine, thirty ball bearing roller skate wheels are assembled per minute with only one observer-operator. At the end of a run one station is modified and two are shut down for production of another type of skate wheel.

Happy result is an improved position of the manufacturer in the market and greater profit through reduction of manufacturing costs. The Hicks Development Division of Ferguson Machine, offering creative engineering based upon proved methods and principles, designed versatility into this machine which became the deciding factor in achieving feasibility of automatic assembly.

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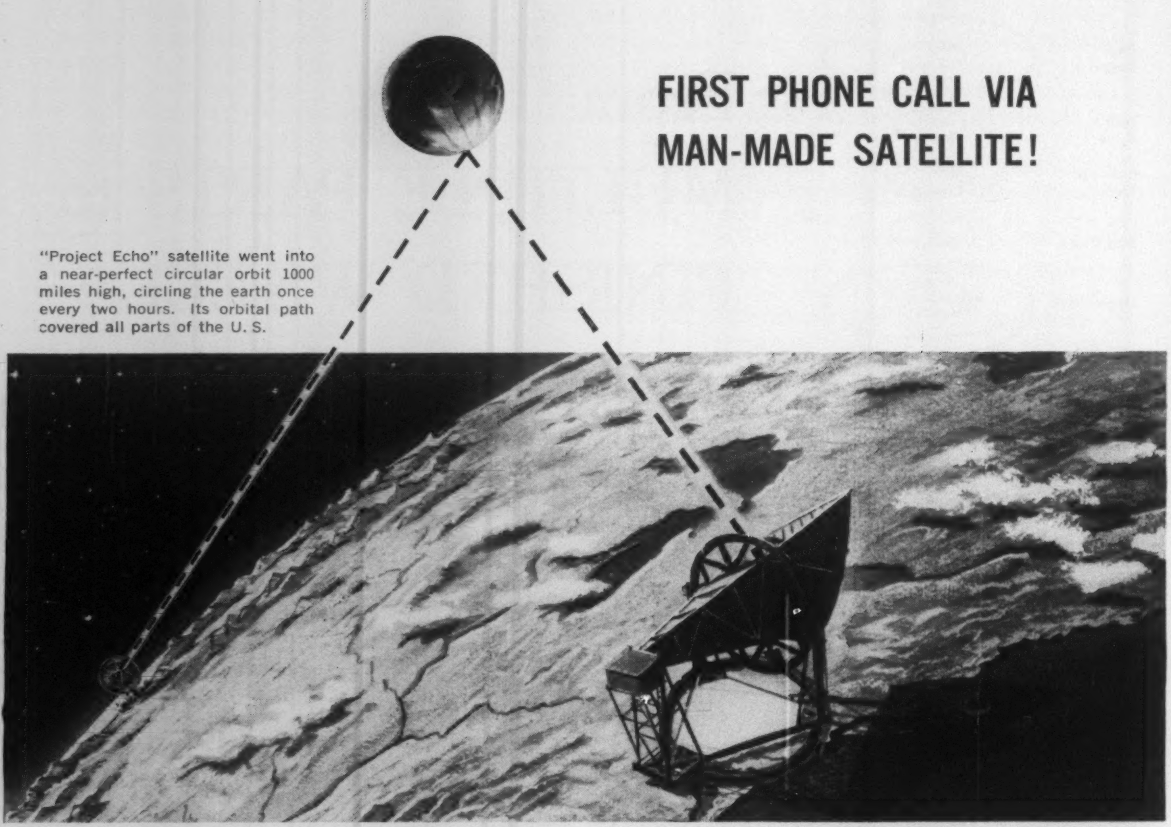


"Project Echo" satellite went into a near-perfect circular orbit 1000 miles high, circling the earth once every two hours. Its orbital path covered all parts of the U. S.

BELL TELEPHONE LABORATORIES BOUNCES VOICE OFF SPHERE PLACED IN ORBIT A THOUSAND MILES ABOVE THE EARTH

Think of watching a royal wedding in Europe by live TV, or telephoning to Singapore or Calcutta—*by way of outer-space satellites!* A mere dream a few years ago, this idea is now a giant step closer to reality.

Bell Telephone Laboratories recently took the step by successfully bouncing a phone call between its Holmdel, N. J., test site and the Jet Propulsion Laboratory of the National Aeronautics and Space Administration (NASA) in Goldstone, California. The reflector was a 100-foot sphere of aluminized plastic orbiting the earth 1000 miles up.

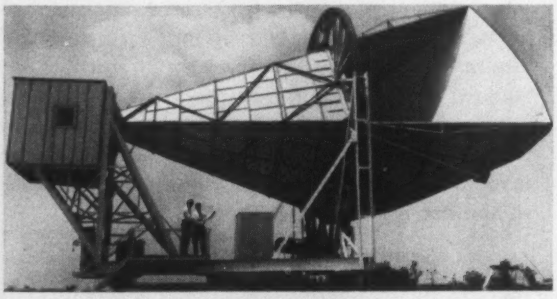
Dramatic application of telephone science

Sponsored by NASA, this dramatic experiment—known as "Project Echo"—relied heavily on telephone science for its fulfillment . . .

- The Delta rocket which carried the satellite into space was steered into a precise orbit by the Bell Laboratories Command Guidance System. This is the same system which recently guided the remarkable Tiros I weather satellite into its near-perfect circular orbit.
- To pick up the signals, a special horn-reflector antenna was used. Previously perfected by Bell Laboratories for microwave radio relay, it is virtually immune to common radio "noise" interference. The amplifier—also a Laboratories development—was a traveling wave "maser" with very low noise susceptibility. The signals were still further protected from noise by a special FM receiving technique invented at Bell Laboratories.

"Project Echo" foreshadows the day when numerous man-made satellites might be in orbit all around the earth, acting as 24-hour-a-day relay stations for TV programs and phone calls between all nations.

This experiment shows how Bell Laboratories, as part of the Bell System, is working to advance space communication. Just as we pioneered in world-wide telephone service by radio and cable, so we are pioneering now in using outer space to improve communications on earth. It's part of our job, and we are a long way toward the goal.



Giant ultra-sensitive horn-reflector antenna which received signals bounced off the satellite. It is located at Bell Telephone Laboratories, Holmdel, New Jersey.

BELL TELEPHONE LABORATORIES

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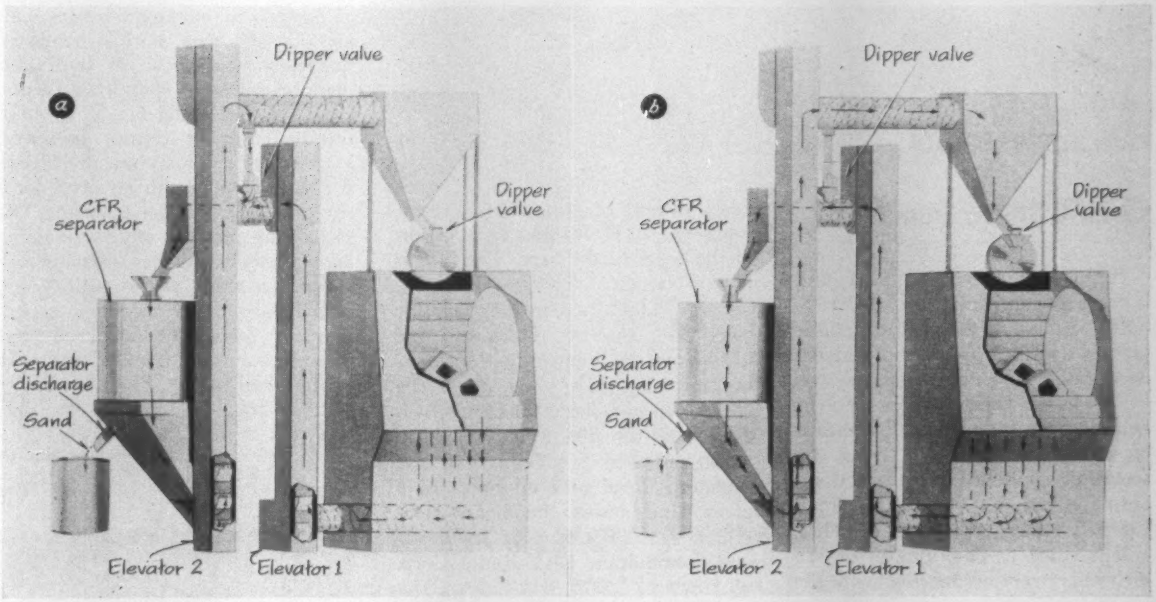


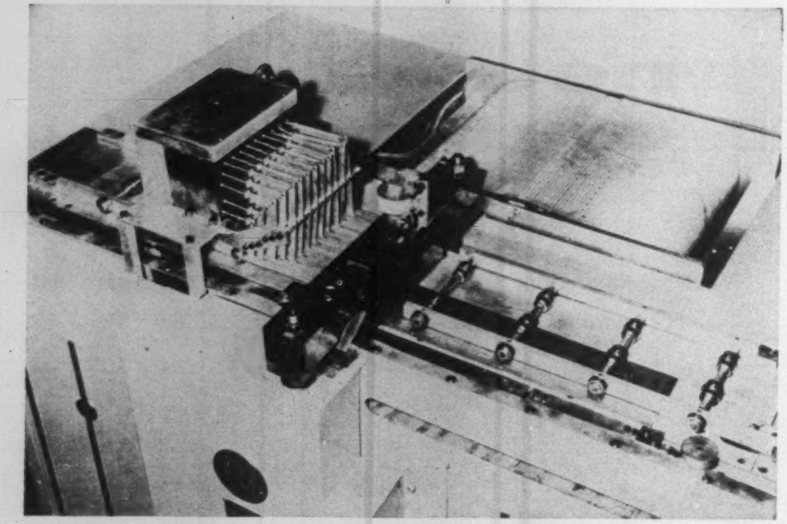
Two abrasive cycling arrangements are provided in tumble blasting machine for core knockout and cleaning of castings. During core knockout, abrasive and large amounts of sand from casting follow the bypass abrasive cycling system shown in **(a)**. For the regular blast cleaning phase, abrasive and remaining small amounts of sand follow the regular abrasive cycling system in **(b)**.

Core Knockout and Blast Cleaning Machine

MACHINE with double elevator design for two abrasive cycling systems has been developed for both core knockout and airless blast cleaning. Designed by **Wheelabrator Corp.**, 1109 S. Byrkit St., Mishawaka, Ind., core knockout and blast cleaning are performed with a single loading and unloading operation. The entire operation is automatically controlled by a sequencing timer, permitting variable time settings for the various phases of operation. Feature of the machine is its compensating flow-round separator designed for the complete purging of sand from an abrasive operating mixture, even when sand loadings approach or equal the weight of the casting being processed.

Operational details of a Super Tumblast utilizing this double section design are as follows: The machine is loaded with cooled castings. The loader empties into a moving conveyor and the castings are tumbled about allowing some of the sand and cores to be knocked loose. During this period, sand is circulated through the bypass abrasive system. The blast wheel is activated for a short period of time to knock out the remaining cores and heavy sand. This introduces a heavy surge of sand into the bypass abrasive system. Sand not removed by the first pass through the separator is recirculated for further air washing. As soon as the core knockout blast is completed, the dipper valve at the wheel closes and contaminated abrasive continues to cycle through the separator. When the cleaning cycle begins, the dipper valve above the separator closes and the abrasive begins to circulate in a complete cycle as the dipper valve above the blast wheel reopens. After the cleaning cycle is completed, the castings are tumbled for a period of time sufficient to drain all abrasive from the castings and prevent carry out of good abrasive.

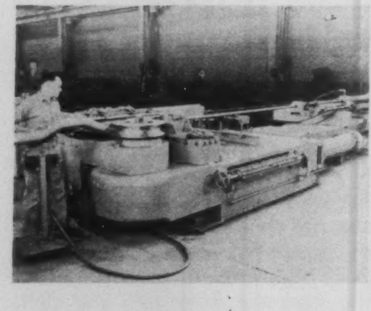
Circle 401 on Page 19



Circuit Board Punch

High-speed tape controlled unit capable of punching up to 10,000 holes per hour is designed to handle printed circuit boards up to 6 inches wide by 18¼ inches long, as well as stacks of sheets which can be held in the same plane by means of suitable fixtures. All holes are accurately punched on 0.1-inch co-ordinates without board breakout. Control tape is 12 by 36 inches, and is ruled in co-ordinates of 1/5 inch. Perforations are made in the control tape with a dinking die at selected intersections. A vacuum head pickup on the reader eliminates the need for precise location of the holes in the tape. The punch head contains 59 free floating punches 0.052 inch in diameter for component insertion holes and one 0.105 inch in diameter for locating or processing holes. Spacing of the 0.052-inch punches is 0.1-inch which establishes the cross grid. The board to be punched is indexed past the punching head and all holes in a given line across the board are punched simultaneously. **Industrial and Automation Div., Radio Corp. of America**, 12605 Arnold Ave., Detroit 39, Mich.

Circle 402 on Page 19



Rotary Bending Machine

Machine is applicable for use in the automotive, boiler, farm equipment, and other industries that form large pipe, tube, channel, angle, and solid bar. It is capable of meeting the heavy bending requirements found in these particular industries. This rotary bending machine is available in two models. When set up for bending heavy materials, the machine is called the Model 6 and will handle production bending of extra-heavy steel pipe up to 6 inches, channel to 9 inches by 15 lb, square steel bars to 4¼ inches, round solid steel bar to 5 inches diameter, and steel angles to 8 by 8¾ inches. When the machine is adapted for handling thin wall tubing it is known as the Model A-8, and is capable of bending tubes up to 8 inches OD with wall thicknesses up to 0.250 inch wall steel tube. Bend accuracy of both models is within ±½ degree. Both are self-contained and occupy a space of approximately 14 by 32 inches including arm swing. A 20-hp motor provides power to the hydraulic system. Angles up to 180 degrees, plus sufficient over-bend to compensate for springback, are formed in a single cycle. Both machines handle bends up to a 42 inch maximum centerline radius. Each phase in the bending cycle is controlled separately by a multiple push button control station that allows stopping and starting at any point in the bending cycle. Machines are available with a degree-of-bend selector and selector knob for indexing the exact angle of bend desired. Up to six different degrees of bends can be preset in advance for jobs requiring mutiple bends in the same workpiece. A hydraulic mandrel extractor is optional equipment on the Model 6. Since most thin-wall tubing cannot be hand loaded over the mandrel, the Model A-8 is equipped with an extra long stroke mandrel loader-extractor. Direct acting pressure die, available as an accessory provides extreme accuracy on short radius, ultra-thin-wall bends. This accessory is particularly beneficial in producing smooth, accurate, wrinkle-free bends in thin-wall tubing. **Pines Engineering Co. Inc.**, 601 Walnut St., Aurora, Ill.

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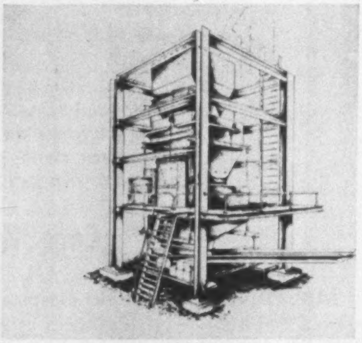
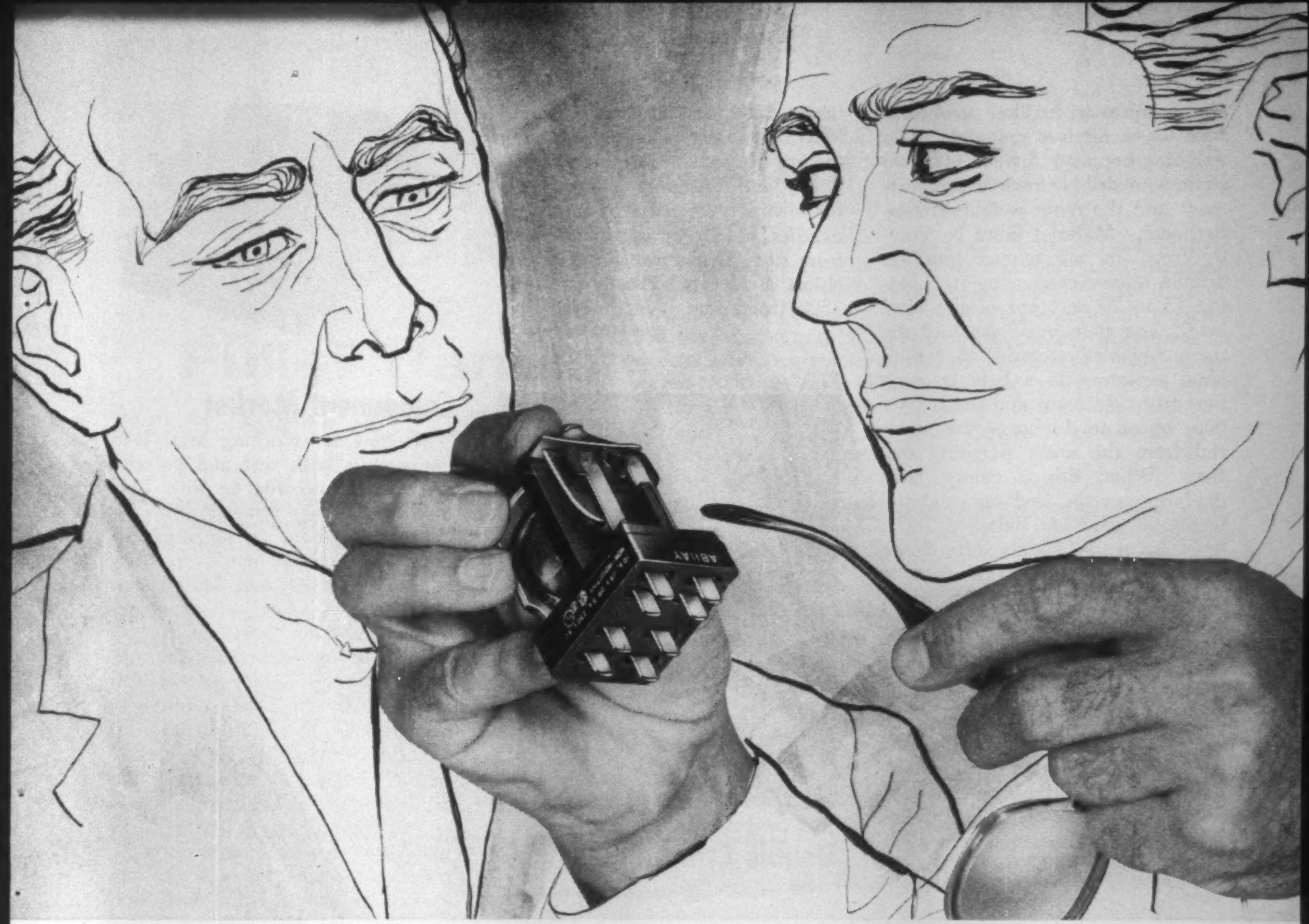


Bulk Weighing System

System is capable of weighing up to 600 tons per hour held to a tolerance of 0.05 per cent per weighing. Available in several sizes, feature of the system is V-37 automatic hopper scale of a beam lever type employing the weighing in and weighing out principle. The system is comprised of suitably-braced structural steel tower, including stairs and platforms, railings, and ladder with safety case, as well as



appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged . . . and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw terminals (adapters), quick connects, or dip soldering.

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

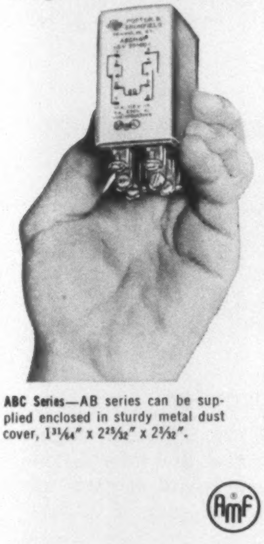
Type	Arrangements	Type	Arrangements
AB7AY	DPST-NO	ABC7AY	DPST-NO
AB8AY	DPST-NC	ABC8AY	DPST-NC
AB11AY	DPDT	ABC11AY	DPDT

Coil voltages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle.

Contact rating 10 amps, 115 volts AC or 5 amps, 230 volts AC noninductive.

U/L File E-29244 CSA No. 15734

Write for complete data or contact your nearest P&B sales engineer.



ABC Series—AB series can be supplied enclosed in sturdy metal dust cover, 1³¹⁄₆₄" x 2²⁵⁄₃₂" x 2³⁄₃₂".

AB AND ABC RELAYS ENGINEERING DATA

GENERAL:

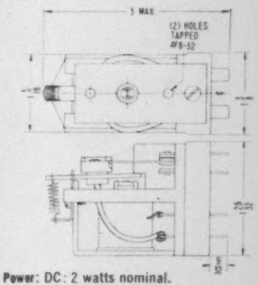
Insulation Resistance: 100 megohms minimum.
Life: 3 million cycles (mechanical).
Breakdown Voltage: 1500 volts rms between all elements and ground.
Temperature Range: DC: −55 to +45°C.
AC: −55 to +45°C.
Weight: AB—5 ozs. ABC—7 ozs.
Terminals: Fit ¼" quick-connect terminals, or may be applied to printed circuits using dip soldering. Screw adapters furnished on request.
Enclosure: ABC: Heavy duty dust cover.
Dimensions: 1³¹⁄₆₄" x 2²⁵⁄₃₂" x 2³⁄₃₂".

CONTACTS:

Arrangements: DPDT
Material: ¼" dia. silver. Other materials available.
Load: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.

COIL:

Voltage: DC: 6 to 110 volts.
AC: 6 to 230 volts.



Power: DC: 2 watts nominal.
AC: 6.4 volt-amps.
Resistance: 35,000 ohms max.
Duty: Continuous: DC coils will withstand 6 watts at +25°C.

MOUNTINGS:

AB: Two 8-32 tapped holes on 1¼" centers.
ABC: One 8-32 stud ⅜" long and locating tab.

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ARE AVAILABLE AT YOUR LOCAL
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IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO
Circle 694 on Page 19

air compressor. The structural steel tower receives material. The weighing hopper is divided into two sections, a dribble reserve compartment and the main weighing compartment. Material flows by gravity from the top hopper into the dribble reserve compartment (holding 15 to 20 per cent of the total load), and then overflows into the main weighing section. A travelpoise is driven to a balance position on its steelyard and the hopper door opens to discharge the material from the main weighing section. When this is empty, twin discharge screws feed out material until the steelyard balances. The screws stop, the hopper door closes, and the travelpoise is returned to zero position. Delivery to the surge hopper is continuous and the scale automatically weighs material in even-amount charges. Complete interlocks are provided to halt operations in event of an emergency. A dial scale with double tape printer and one drop weight is available in place of the dribble reserve compartment with twin feeding-out screws and dual beam system. **Richardson Scale Co.,** Clifton, N. J.

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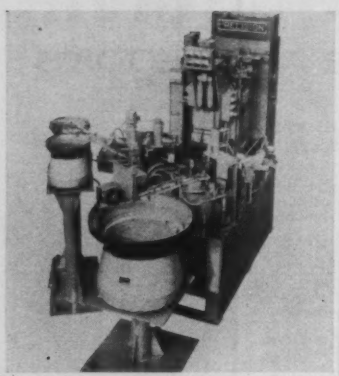

Dial Feed Welder

Line of precision dual head ABV-3 dial feed bench welding machines is designed for mass production welding of small parts. Welder shown has a six station dial feed mechanism, three vibratory hopper feed units, and an automatic ejector mechanism. It simultaneously projection welds support ears to the ends of two styles of yokes for a duplex electrical outlet. Production is 1500 to 1700 parts per hour. Machines can be equipped with tooling to satisfy forming, assembling, and fastening requirements for a variety of parts in many industries. Models are available with from 10 to 50 kva transformers. **Precision Welder and Flexopress Corp.,** 3520 Ibsen Ave., Cincinnati, Ohio.

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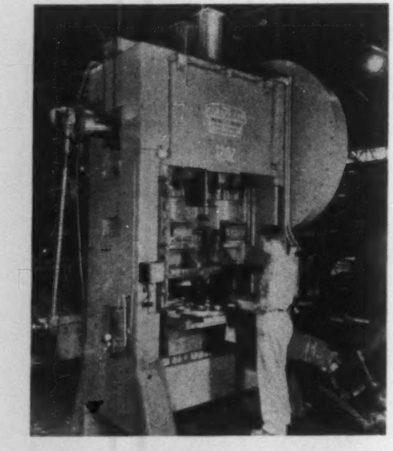

Double Crank Press

By modifying various dimensions such as stroke, slide adjustment, bed and slide areas, 150-ton double crank press is engineered to do a wide range of production operations including punching, shearing, perforating, bending, and forming. It is designed for automatic feeds and uninterrupted production. Equipped with a multistation feed, the press on each stroke is piercing, extruding, and forming oval or round muffler heads. The automated mechanism has two stations outside the ram area allowing the operator to feed blank stock and also inspect the formed part while the press is operating without interruption. The oval heads are being formed at the rate of 45 strokes per minute while the round ones are being produced at 35 strokes per minute. While presently operating at 45 strokes per minute, this machine is designed so that it can be adjusted to operate at 55 strokes per minute. The press has an 8-inch stroke of slide with a 6-inch adjustment. It has a single-end drive. **Cleveland Punch & Shear Works Co.,** 3917 St. Clair Ave., Cleveland 14, Ohio.

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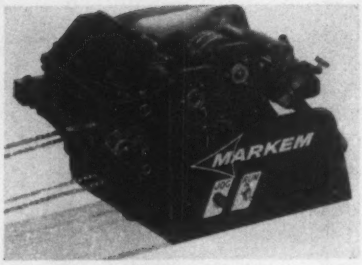

Component Marker

Machine for marking axial lead components with text and polarity markings in accordance with JAN specifications has production speeds of 2600 and more per hour. Model 146A prints trademark, polarity symbol and band, and desired code markings on diodes, capacitors, resistors, and other axial lead components with curved or irregular surfaces. With optional features, this machine will also handle units with header leads. Visibility of imprints on crystal components can be increased by printing on a background color, using a combination of two machines, one feeding automatically into the other. Unit uses quick-change type inserts. Maximum print size is 1 inch wide by 2¼ inches long. A wide range of air-dry or baking inks in RETMA colors is available. The machine can be quickly adjusted to accommodate units of various sizes; axial lead components 0.080 inch to 1 inch in diameter, with body length from ¼ to 1⅛ inches and over-all length from 1¾ to 4¼ inches, can be handled. **Electrical Div., Markem Machine Co.,** Keene 48, N. H.

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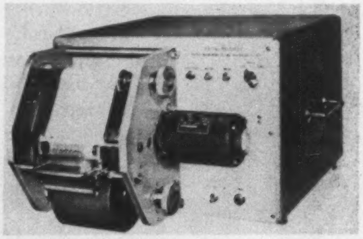

Digital Recorder

Binary recorder features high-speed transfer of digital information to a permanent record at rates up to 150 lines (or words), of 32 bits

More "PAY-DIRT" With Fuller Panels In Control

One man on watch—and a Fuller Control Panel in control. Result: the flow of bulk, dry materials in a pneumatic conveying system graphically illustrated by diagrams and indication lights that track process transitions from phase to phase—without human errors!

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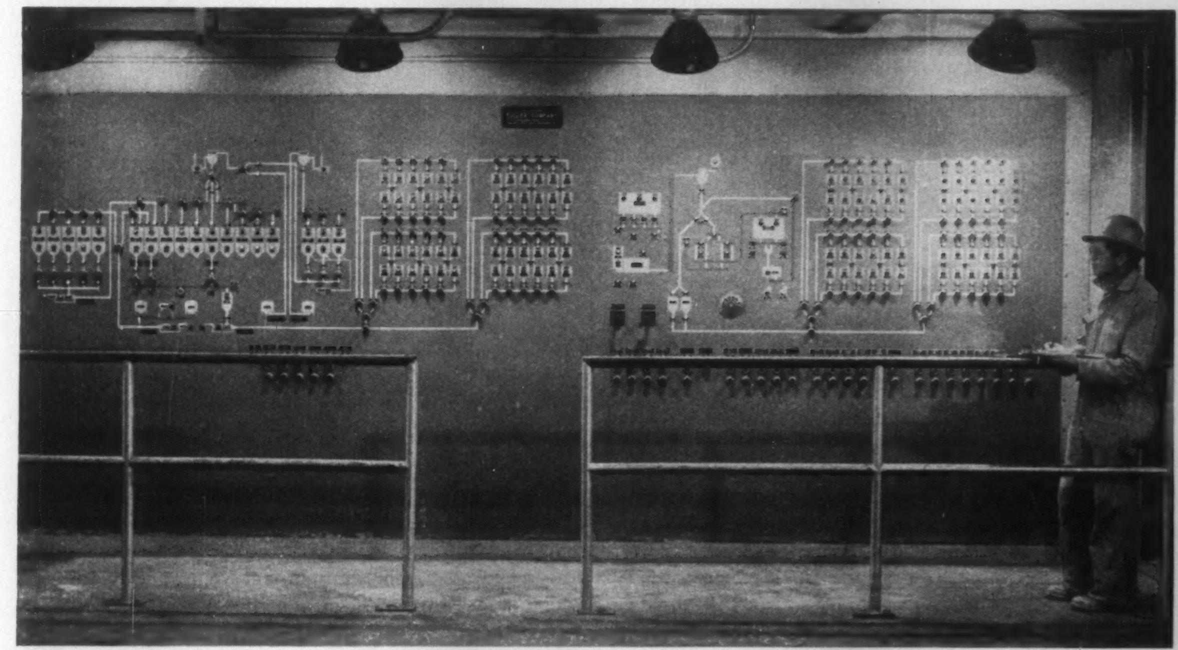

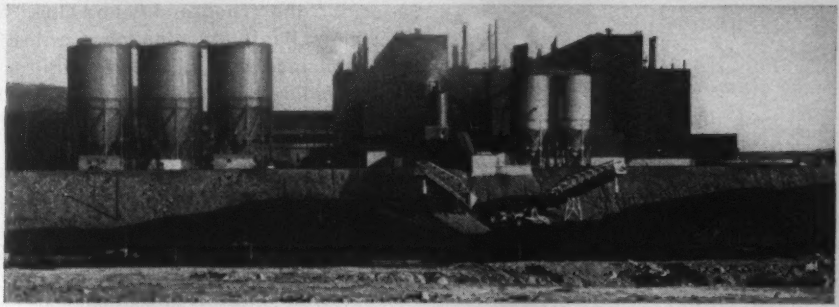

Look to Fuller's engineering-manufacturing team to develop the simplest possible control system without costly duplication or changes for you. Write for Bulletin G-9, today.

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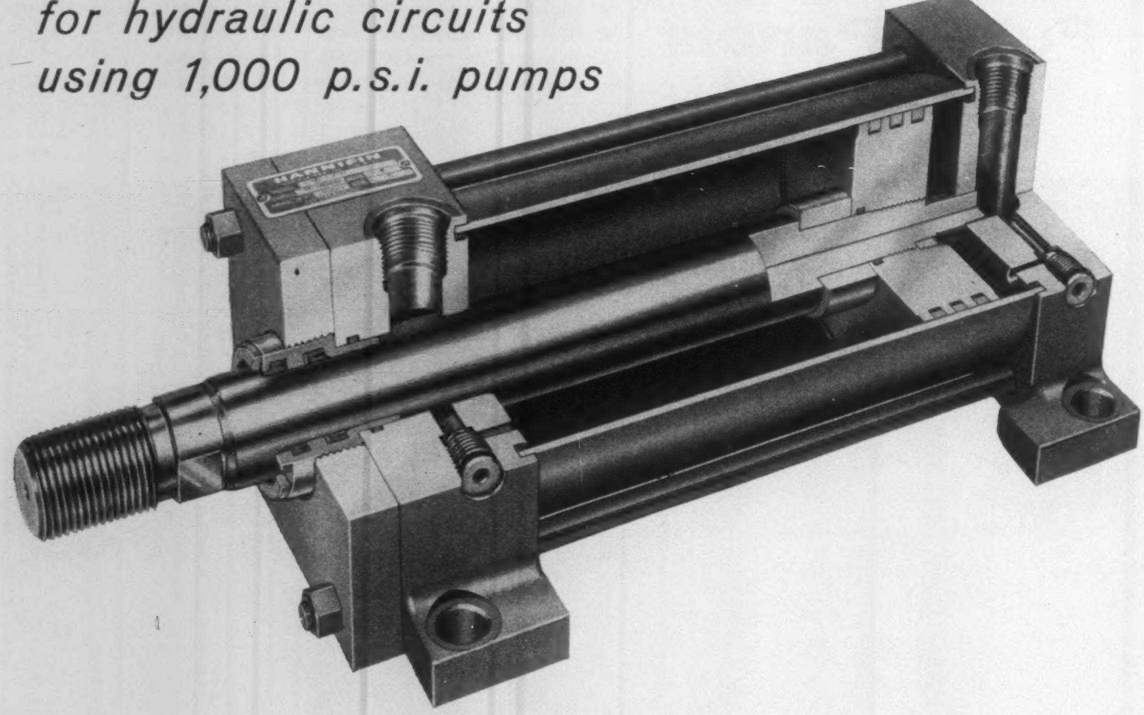
Circle 695 on Page 19

NEW FROM HANNIFIN
THE THOUSAND POUND LINE!

for hydraulic circuits
using 1,000 p.s.i. pumps



- *A true hydraulic cylinder — not a modified air cylinder*
- *Offered in nine bore sizes — 1" through 8"*
- *Every model withstands at least 1,000 p.s.i. in every bore size*
- *Built to save you money — yet not "built to a price"*

Now, for the first time in hydraulic cylinder manufacture, Hannifin offers a top quality cylinder tailored to the medium-high-pressure hydraulic circuits you operate off 1,000 p.s.i. pumps.

Series "L," the "Thousand Pound Line," is NOT a modified heavy duty air cylinder. It is built for the job . . . with steel heads and steel barrel for full compliance with J.I.C. hydraulic recommendations. Other extra-quality features include an induction hardened and hard chrome plated rod, nodular iron piston with cast-iron piston rings — leakproof "Lipseals®," optional — longer cushions on cushioned models, and the Hannifin-developed bronze cartridge gland with both "Lipseal®" and "Wiperseal" to keep the rod drip-free. S.A.E. straight thread "O" ring ports as recommended by J.I.C. are optional at no extra cost just as they are in the Hannifin heavy duty Series "H" hydraulic cylinder.

Parker-Hannifin field engineering service can help you meet your needs precisely, help you select the proper Hannifin cylinder for any service, air or hydraulic. Call your nearest Parker-Hannifin sales office or write direct for our new bulletin giving all dimensions of Hannifin Series "L" cylinders.

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PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

8077-PH

each, per second with compatibility to digital data sources. Applications include check-out systems, quick look recording for digital computers, sequential time interval measurements, geophysical recording, telemetering, and digital meters. Available for bench or standard rack mounting, Model 960 measures 12¼ inches high and 16¾ inches from mounting panel to rear. Standard designs include up to a maximum of 32 recording channels and an ungated time mark channel. Higher data capacity and paper speeds are also available. Necessary circuits to couple directly to dc levels derived are included. Recording control from external command signals is built-in. A recorded bit is made for a minus 10 v input defining a logic "1." For logic "0," zero voltage at the input inhibits recording. A time tested drive system moves the electrically sensitive recording paper at speeds from 2.5 to 25 inches per second for either continuous or intermittent operation. Standard paper rolls are 4½ inches by 400 ft and allow over 50,000 recordings on one loading. **Electronic Counters Inc.**, 155 Eileen Way, Syosset, L. I., N. Y.

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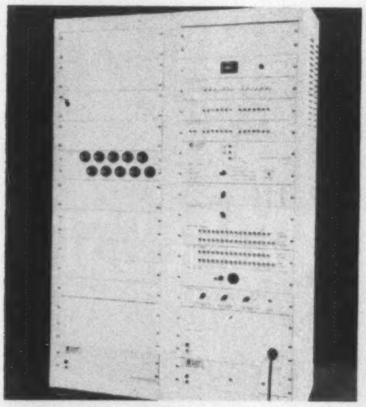

Memory System Tester

Capable of testing memory systems with planes up to 128 by 128, this memory exerciser has been developed to locate defects automatically in coincident current core memory systems. Model 1513 detects and counts defective cores that are either dropping *one* or picking up an extra *one*. The exerciser provides a variety of checkerboard patterns to facilitate operation under worst case noise conditions. Its variable timing cycle is capable of operating down to 5 microseconds. The exerciser may be made to stop on an error to determine its location, or it can pause on the error and then continue. **Digital Equipment Corp.**, Maynard, Mass.

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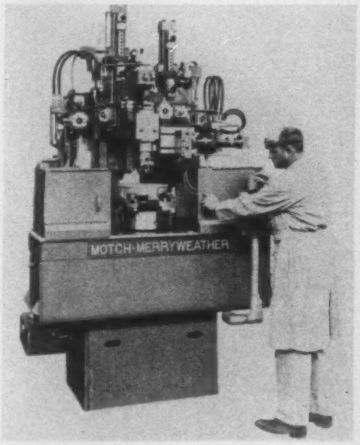

Vertical Turner

Machine has been developed to perform boring, facing, and turning operations, either in rough or finished form. Model 1-V has been assembled of components produced in lots to hold down costs. It is able to make a mass chip-removal attack on the object being turned. To change the chip removal operation of the vertical turner, it is only necessary to reposition slides on which the cutting tools are mounted, or adjustments can be made in the control system. Rigid, internally ribbed cast iron bases and columns are finished in multiple lots. These are assembled like building blocks to make a machine which has one or more spindles, with many hydraulically controlled tools on slides mounted on columns to remove metal as required by the job specifications. Micrometer adjustments of the positive stops in the hydraulic slide movement impart a high degree of accuracy to the machine. **Motch & Merryweather Machinery Co.**, E. 222nd St., Cleveland, Ohio.

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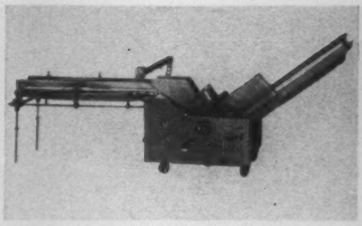

Box Stacker

Stacking machine for setup boxes is designed to simplify size changes. Changeover time is three minutes. Variable stacking speeds from 28 to 100 units per minute handle the output from any wrapping or staying machine and almost any other type of boxmaking equipment. Loose or tight nesting of boxes can be provided by this machine. Boxes as small as 4 inches in length and ½ inch in depth can be handled. Maximum independent dimensions are 20 by 15½ by 4½ inches. Other features of the stacking machine include swivel casters, prelubricated ball bearings, and elimination of all gears. **FMC Packaging Machinery Div.**, 4992 Summerdale Ave., Philadelphia 24, Pa.

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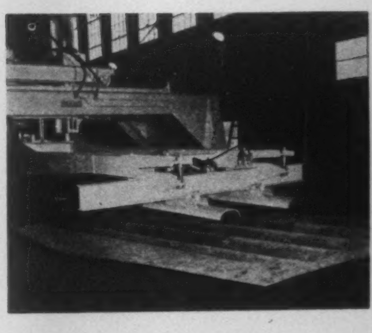
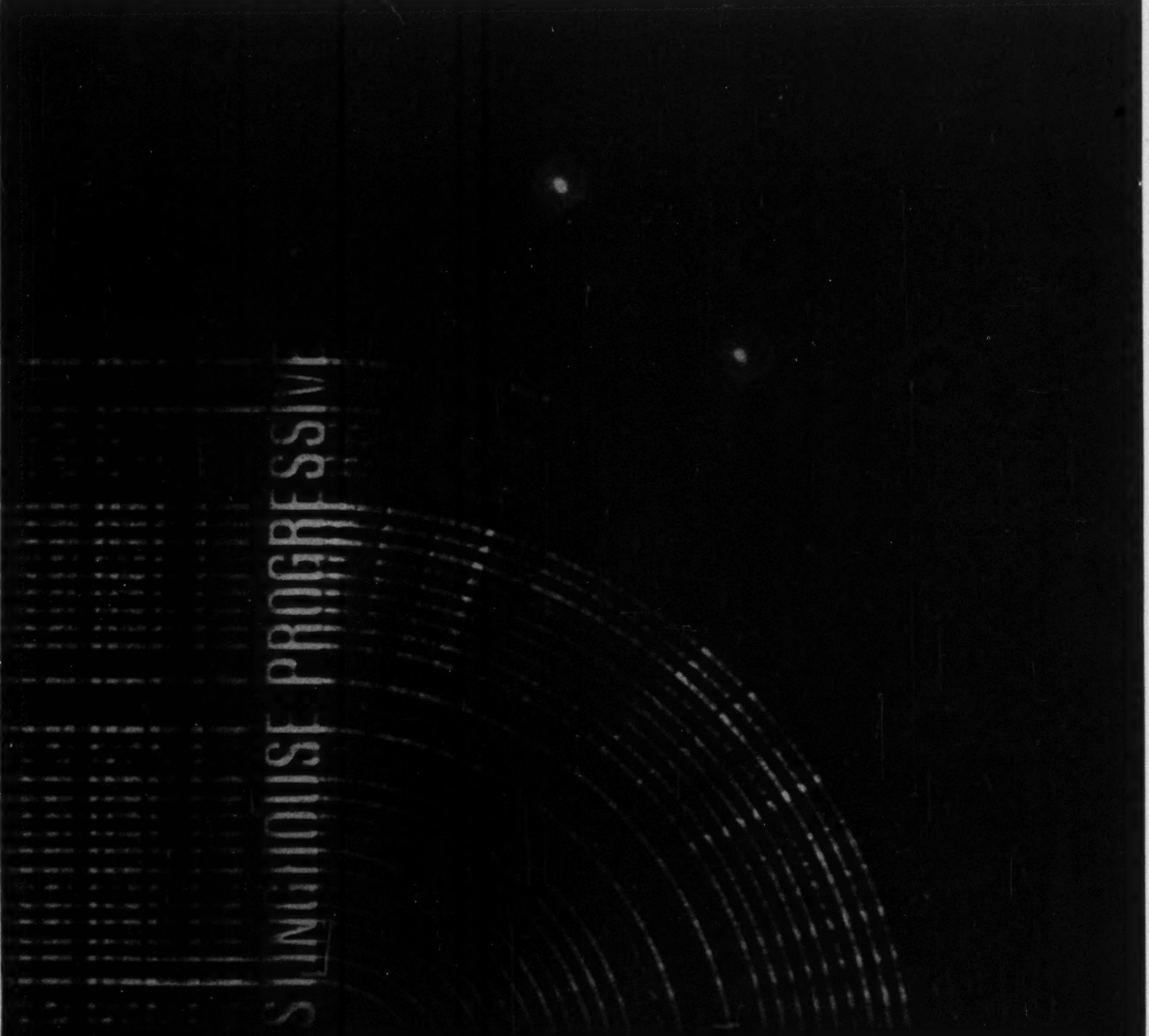


Gantry Vacuum Lift

Cantilevered arm gantry vacuum unit is designed to feed an 1800-ton, narrow throat forming press with either flat or corrugated steel plate used in the assembly of railroad gondola car ends. Gantry can be controlled automatically or semiautomatically, traversing material to position without lateral or transverse sway. Device is an over-all self-contained unit with integral wiring and power, hydraulic drives, and lifting devices. It also has a sidewise positioning mechanism. Pads used in lifting and feeding the corrugated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OUTPUT, PROFITS
THROUGH COORDINATED
AUTOMATIC PRODUCTION

AUTOMATION

Westinghouse *Progressive Automation* is a long-term plan leading to automated production with minimum capitalization. It is designed to help manufacturers gain better product quality through step-by-step control of operations.

In fact, *Progressive Automation* has already been carried to its logical conclusion: completely automatic production. In the steel industry alone, three computer-controlled systems have been sold. Here the entire drive systems, supplied by Westinghouse, provide coordination of rolling mill operations under the command of a computer.

AUTOMATION . . . STEP BY STEP—Westinghouse is ready to work with you in planning economical steps to automatic operations . . . without under- or over-automating. Step-by-step automation starts with the many modern Westinghouse controls, motors and drives at work in plants today. Each was designed to achieve an immediate production objective . . . to control a single machine, a conveyor line or an entire installation. Through *Progressive Automation*, you next add other Westinghouse coordinating controls and systems—all of which are compatible with those already in place. Your eventual target may be all production facilities fully coordinated with the Westinghouse industrial control computer.

PROGRESSIVE AUTOMATION ALREADY AT WORK—*In the paper industry,* PULSETTER* makes possible new standards of accuracy and product quality in paper production. The PULSETTER control system uses digital circuitry to maintain accurate synchronization of the speed *and* position of all sections of a paper machine. Accuracies can be maintained to only a 5″ variation in 2000 feet of paper.

In the chemical processing industries, Westinghouse provides OPCON* which experiments, then finds and controls optimum production efficiency.

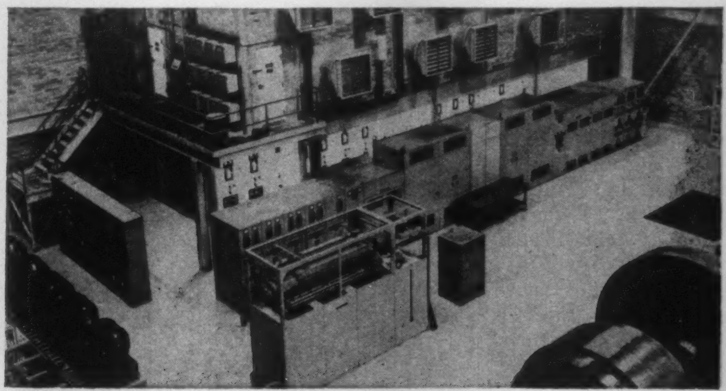
For the primary metals industry, installations of Westinghouse PRODAC* (programmed digital automatic control) have improved product quality and mill functions, as well as monitoring all phases of the product and process by data accumulation systems.

For the first time, there is now one source for all your automation needs: Westinghouse computers, controls, drive systems, transformers, motors, gearing, switchgear . . . and Westinghouse assumes full electrical system responsibility.

Call on Westinghouse and detail your objectives. We are prepared to work out your automation plan . . . furnish, install and maintain the necessary electrical equipment. Your Westinghouse representative has complete details on *Progressive Automation*.

*Trade-Marks
J-96144

PRODAC control computers are designed to work in unison with conventional control equipment. Result: full automation of plant or process becomes a practical reality.



YOU CAN BE SURE...IF IT'S Westinghouse

gondola car ends are of special design to fit the formed steel plate. Standard model pads are used on the flat steel plate stock. **Vac-U-Lift Co., Div., Siegler Corp.,** Salem, Ill.

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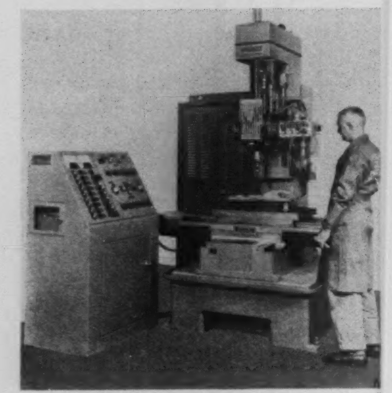

Layout Drilling Machine

Layout drilling machine uses numerical control with both tape and dial input to provide a large degree of flexibility. Travel depths of the spindle, speeds, and feeds are electrically controlled without using the tape of the table positioning control other than to send a signal to the machine to select operating conditions which have been pre-set. Nine sets of operating conditions can be set up at a time. To set up the conditions for a given operation, the machine operator sets knobs for speeds and feeds, and sets stops for rapid advance and feed travels. After the setup is completed and the workpiece is in place, a prepared tape is placed in the tape reader, and a *Cycle Start* button is pressed. The machine proceeds to select the speeds, feeds, rapid traverse, and depth settings already set up for the particular operation. The table moves to the command position and initiates the spindle feed cycle. Capacity of the machine is holes 1 inch in diameter in cast iron and 7/8 inch in mild steel. Spindle travel is 7 inches, sliding arm travel is 10 inches. Compound table travel is 14 by 20 inches. Spindle speeds range from 225 to 2700 rpm; spindle feeds from 1 to 7 ipm. **Edlund Machinery Co., Div., Harsco Corp.,** 112-70 Huntington St., Cortland, N. Y.

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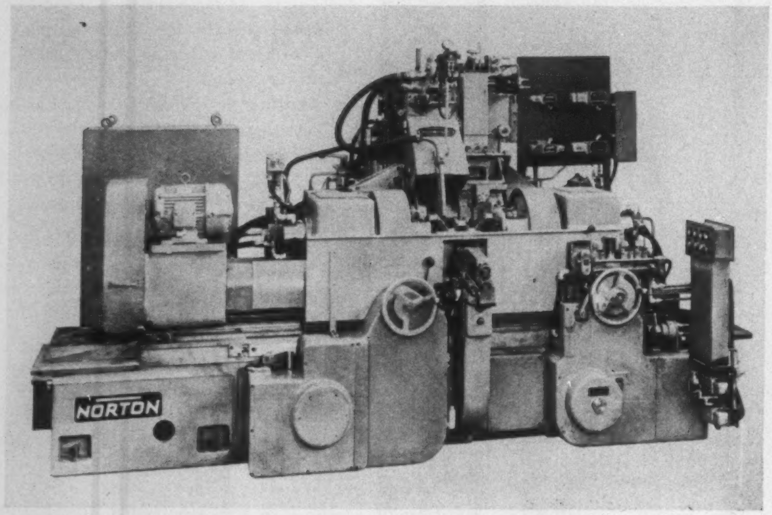

Continuous Wheel Truing Grinder

Machine is designed to grind the crankpin diameters of automotive type crankshafts one pin at a time. Indexing of the table for different pins is accomplished by hydraulic power under control of a lever. Feature of the CC-8 Crank-O-Matic is the continuous path truing of wheel face and radii at the touch of a pushbutton. Truing of the full grinding face includes corner radii. Mounting of the grinding wheel spindle eliminates spindle deflection under load. A torque equalizing work drive rotates the two work heads with equal torque preventing twist in the shaft. During the grinding cycle, the wheel advances to the work in five definite steps. Rapid traverse brings the wheel to the work, the feed shifts to shoulder grinding feed, then slows down for grinding the diameter. The wheel dwells to round up the diameter and then the wheel advances slowly to achieve the final size. Automatic gaging provides a signal to retract the wheel. Maximum swing capacity of the grinder is 17 inches and it is available for work lengths of 32, 42, and 72 inches. Optional features include: Automatic table indexing, automatic spark splitter, side wheel truing device, automatic wheel wear compensation, automatic diamond turner for crank wheel truing device, and automatic constant peripheral wheelspeed. **Norton Co.,** Worcester 6, Mass.

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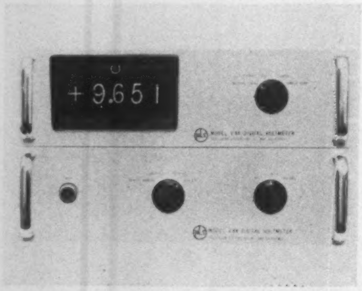
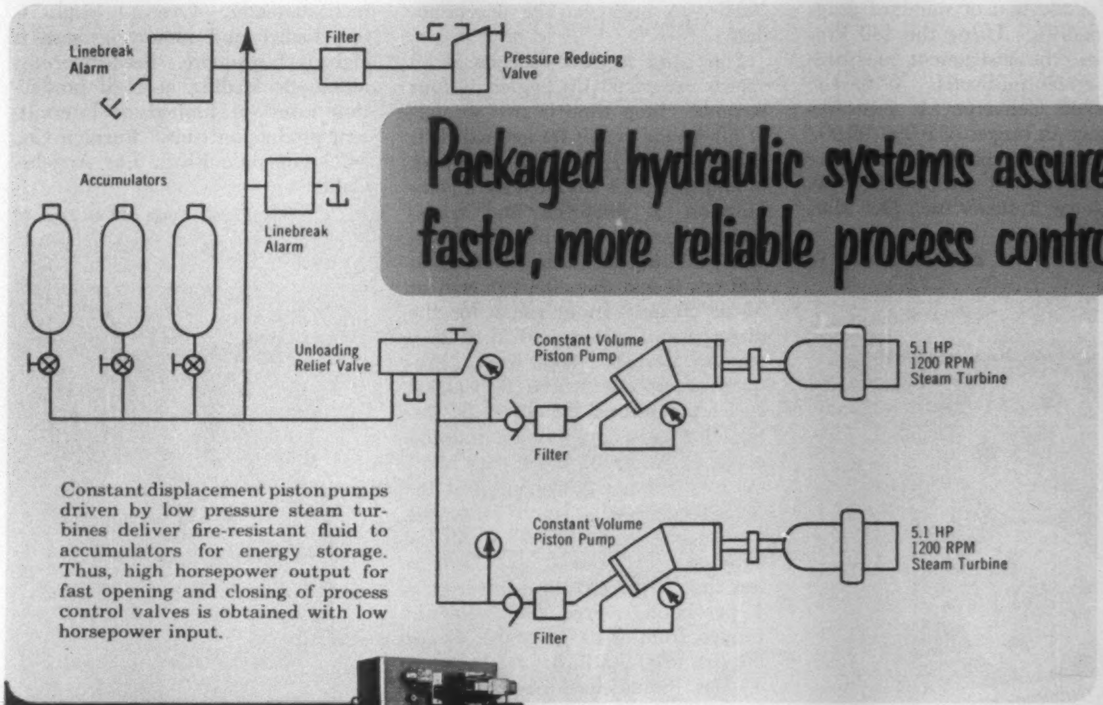


Digital Voltmeter

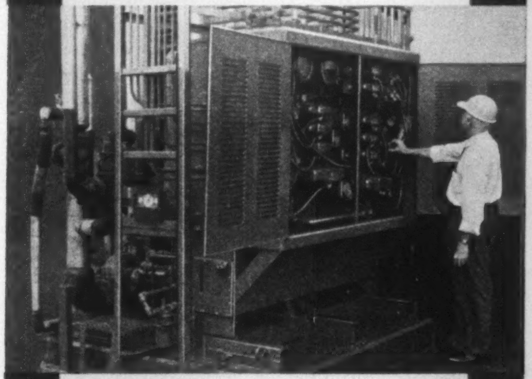
All-electronic digital voltmeter is designed for measuring and data logging applications that demand maximum speed with stability and reliability matching that of electromechanical instruments. Model V44 makes 200 readings per second in ranges of ±9.999/99.99/999.9 v dc. Its accuracy is ±1 digit and its input impedance is 10 megohms. It has no pots in its decade circuits. Instrument has a balancing time of 5 milliseconds which permits high-speed measurement of transient data in such applications as laboratory research, and high-speed production testing. The V44 features snap-out readout for 20-second bulb replacement without the use of tools or soldering. It measures either low-level dc voltages or ac

Packaged hydraulic systems assure faster, more reliable process control


Linebreak Alarm
Filter
Pressure Reducing Valve
Accumulators
Linebreak Alarm
Unloading Relief Valve
Constant Volume Piston Pump
5.1 HP
1200 RPM
Steam Turbine
Filter
Constant Volume Piston Pump
5.1 HP
1200 RPM
Steam Turbine
Filter

Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

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with the addition of standard plug-in accessories. Using the 140 Preamplifier, the instrument measures ±99.99/99.9 millivolts. With the 125 ac/dc Converter, it measures ac voltage in ranges of 9.999/99.99/999.9 from 30 cps to 10 kc. Circuits and readout are plug-in type. **Non-Linear Systems Inc.**, Del Mar, Calif.

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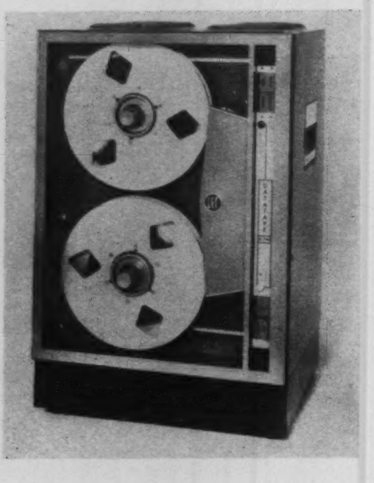

Tape Recorder-Reproducer

All-solid-state magnetic tape recorder/reproducer is designed to offer the features of larger instruments in a small package. Model PR-2300 is $22\frac{3}{4}$ inches high, $17\frac{3}{4}$ inches wide, 15 inches deep, and weighs less than 150 lbs. Mounting may be either vertical or horizontal. Electronics are mounted similarly but are only $3\frac{5}{8}$ inches in height. Each case holds up to 14 plug-in record or reproduce amplifiers. Up to 14 channels of direct-record or wide-band FM analog data can be recorded and played back bidirectionally. Head assemblies for two record and two reproduce heads of seven channels each can be plugged in. Accessory erase head is also available. Unit records and reproduces at speeds of 60, 30, 15, $7\frac{1}{2}$, $3\frac{3}{4}$, and $1\frac{7}{8}$ ips. Speeds are changed in pairs by changing drive belts. Choice between the two speeds in each pair is made from pushbutton controls. Tape speed is held constant to within 0.25 per cent. Tape widths can be $\frac{1}{4}$, $\frac{1}{2}$, or 1 inch. Reels in diameters up to $10\frac{1}{2}$ inches and with NAB-type hubs can be accommodated.

Start time is three seconds at all speeds except 60 ips, which is four seconds. Stop time is two seconds at all speeds except 60 ips, which is three seconds. Automatic stopping at end of tape is initiated by a combination of photocell and transparent section of tape. Cumulative peak-to-peak flutter from dc to 300 cps is less than 0.4 per cent at 30 or 60 ips. Input range for the direct record system is 0.25 to 25 v rms for normal record level. Frequency response is 100 to 100,000 cycles per second ±3 db at 60 ips. Signal-to-noise ratio is a minimum of 38 db from 300 cps to the highest frequency response specified for each tape speed. Input range for an FM system is 0.5 to 50 v rms for 100 per cent modulation. Drift is less than 2 per cent and linearity is 1 per cent. Frequency response ranges from 0-10 kc ±0.5 db at 60 ips to 0-0.312 kc ±0.5 db at $1\frac{7}{8}$ ips. Signal-to-noise ratio ranges from 43 db at 60 ips to 35 db at $1\frac{7}{8}$ ips. Unit operates on 115 v, 60 cps current at temperatures from 40 to 125F and humidity to 100 per cent. **Consolidated Electrodynamics Corp., Subsidiary, Bell & Howell**, 360 Sierra Madre Villa, Pasadena, Calif.

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Parts Feeder

Designed for use with small or miniature type parts of less than $\frac{1}{2}$ inch in length, vibratory parts feeder is a compact low cost unit. It is complete with built-in control and interchangeable bowl of seven inch diameter. Over-all height is $6\frac{1}{2}$ inches and mounting base is eight inches square. Feeder permits automatic feeding at high production rates on limited or intermittent production runs. **Burklyn Co.**, 3429 Glendale Blvd., Los Angeles, Calif.

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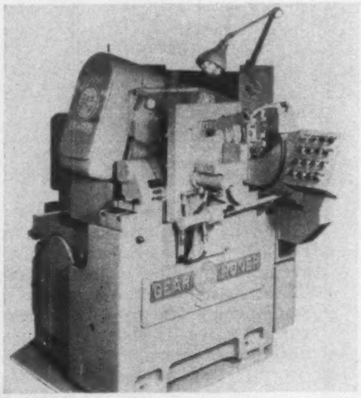

Honing Machine

Machine is designed to perform four separate methods of honing hardened gears. These include: Honing with backlash in conjunction with a patented locked honing head, zero-backlash operation with precision-pressure control in conjunction with the patented honing lock, constant-pressure operation with mechanical wedge type back-up eliminator, constant-pressure operation with overload relief provided by an adjustable leaf spring back-up protector. Model GHD can be equipped with an automatic loader for honing small helical pinions. It has the work mounted on its bore and faces. The honing tool is on a slide behind the work-table and drives the work gear in both directions of rotation while the honing head reciprocates back and forth. This 12-inch gear tooth honing machine is capable of honing gears from 4 to 20 diametral pitch ranging in size from 1 to 12 inches. Calibrated controls provide for accurate setting of vital honing pressure. The maximum distance between centers is $10\frac{1}{4}$ inches; cutter head stroke is $5\frac{1}{2}$ inches maximum. **National Broach & Machine**, 5600 St. Jean Ave., Detroit 13, Mich.

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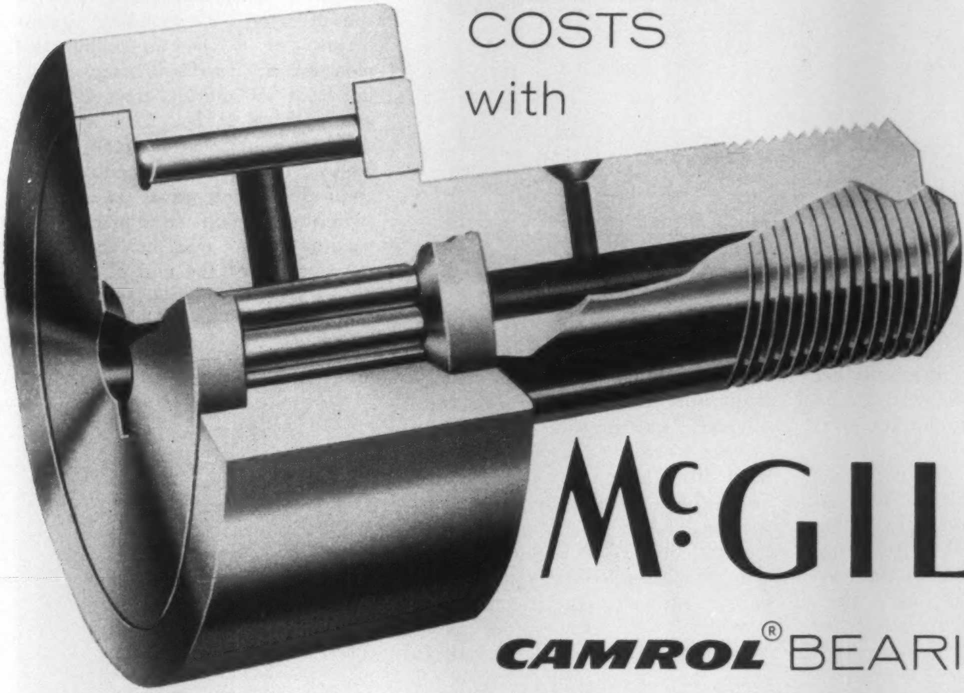
ELIMINATE UNNECESSARY ASSEMBLY COSTS with



Replace improvised units with readily available precision cam followers.

McGILL®

CAMROL® BEARINGS

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The original and still unsurpassed anti-friction roller bearing cam-follower bearing that adds efficiency at less cost to cam actuated, track and support roller applications. Built with full roller complement and integral stud, the CF series design provides high radial capacity and shock load protection in a compact roller with its own shaft. Easily applied and available in roller diameters of ½″ to 4″.

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Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.

SCYR SERIES
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CYR (Cam Yoke Roller) SERIES

The CYR series increases the adaptability of the CF bearing to all types of automatic machinery involving cam action or controlled-motion machine parts that require guide or support rollers. An inner ring replaces the stud for cam yoke roller mountings.

Write for Catalog No. 52-A for full information on McGill's needle roller bearings, and cam followers. Ask about recommendations for high precision special ball and roller bearings.

SCYR SERIES

This series provides a fully sealed Cam Yoke Roller type bearing. It is dimensionally interchangeable with the CYR bearings.

McGILL MANUFACTURING CO., INC., Bearing Division
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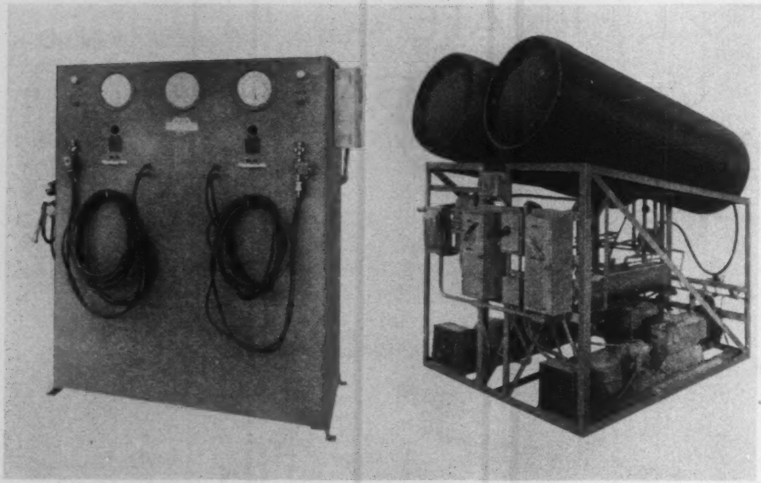
McGILL®

precision needle roller bearings



Air Conditioner Test Unit

This self-contained machine has been developed for the testing and activating of air conditioning units for automobiles, just before the cars reach the end of the assembly line. It is designed to handle two assembly lines simultaneously. Dry air with a minus 100 F dew point is used to clean the entire air conditioning system in the car. Then the system is thoroughly tested for leaks by the introduction of nitrogen-Freon vapor under 200 psi pressure. The nitrogen-Freon vapor is reclaimed to two psi pressure for reuse. The system is then evacuated to 29.3 inches of mercury. At this point the machine introduces the correct weighed charge of refrigerant into the automobile air conditioner, automatically refills its its own weighing cylinder, and cuts itself off. Safety valves and automatic flash controls are built into the machine to insure safe and automatic control of the entire operation. Two tanks supply the refrigerant required to permit continuous operation. A test control panel with its automatic or flash controls keeps the operator informed at all times on how the machine is operating. **Alpha Electric Refrigeration Co.**, 1115 E. Seven Mile Rd., Detroit 3, Mich.

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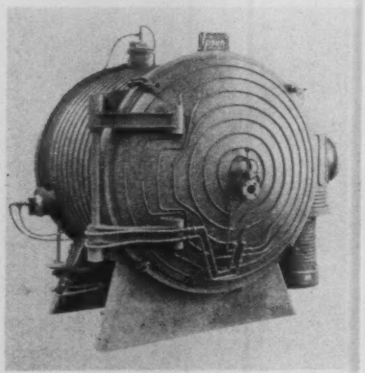

Heat Treating Furnace

High vacuum cold wall type furnace with a 200 lb capacity has been developed specifically for high temperature copper brazing and heat treating of gas turbine parts and assemblies. It can be used for hardening, tempering, drawing, and annealing refractory metals and stainless and special alloy steels. Series V-5-750 has an operating temperature of 2600 F, a maximum operating pressure of 0.1 micron Hg, and takes a power supply of 150 kw/hr. It has a transformer built in for operating 110 v control circuits. This furnace is charged horizontally and has a molybdenum hearth. The pumping system consists of a 120 cfm mechanical pump and a 16-inch diameter vapor diffusion pump capable of a pump downtime from atmosphere to 1 micron Hg in less than 20 minutes. The furnace employs graphite heating elements (Molybdenum heating elements are optional), and multiple radiation shields which are easily removed for maintenance and replacement purposes. The control panel has a switch allowing the furnace to be set for manual or automatic operation at the will of the operator. The cooling system consists of a vacuum sealed fan mounted within the furnace. Cooling from 2600 to less than 400 F is accomplished in less than one and one-half hours. Safety features include a thermocouple vacuum gage controller which serves as a safety switch to set off an alarm if the vacuum system does not reach 100 microns Hg at the end of a preset time. **Ipsen Industries Inc.**, 721 S. Main St., Rockford, Ill.

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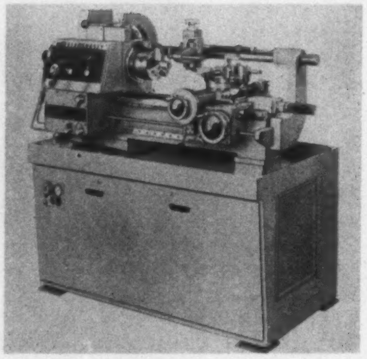
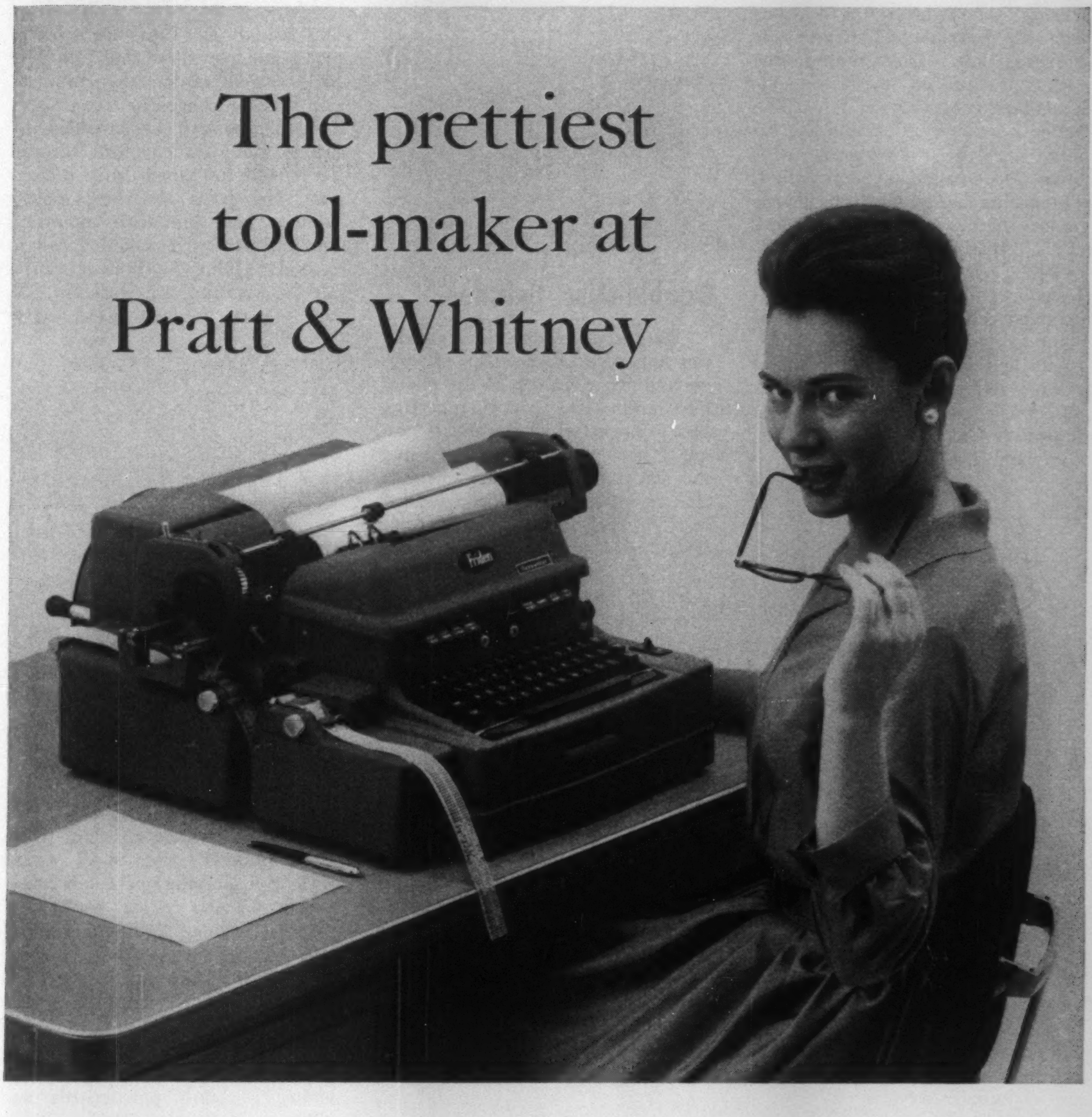


Turret Lathe

Precision chucking turret lathe is one in a line designated No. 2 Micro-Cut. Lathe is designed to handle the most critical machining requirements of medium to small size precision parts. It is designed to retain the over-all ruggedness and universal characteristics of a turret lathe and add the accuracy capabilities of a precision instrument lathe. The unit features an eight-station cross sliding turret of flat design with tangential T slots for mounting tooling. It offers power feed in both directions; 0.0015 to 0.017 inch longitudinal and 0.0007 to 0.008 inch cross. Eight stops for longitudinal and six for cross positioning are provided. A single lever in the center of the turret unlocks the unit, permitting the turret to be spun by hand in either direction. Station positions are indicated by

The prettiest tool-maker at Pratt & Whitney



She probably wouldn't know a micrometer from a hairpin, but using that Friden Flexowriter®, she's preparing a numerical control program tape which helps speed production of tools that are faster, more reliable and far more accurate than ever before.

Today, Pratt & Whitney Company is building five different types of numerically controlled machine tools—*and using numerically controlled tools to do much of the work!*

Significantly, Pratt & Whitney now uses eight-channel punched paper tape control exclusively. After much experimentation, P&W, like so many others in the field, has chosen punched paper tape as the best all-around input medium. Reliable, dependable, easy-to-program—punched paper tape is fast becoming the one thing that most numerically controlled tools have in common.

THIS IS PRACTIMATION: The Friden Model NC-1 Flexowriter is a perfect example of what we call PractiMation—automation so hand-in-hand with practicality there can be no other word for it.

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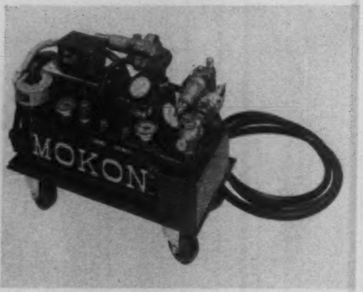
Circle 700 on Page 19

detents. The lathe swings 14 inches over the bed and six inches over the cross slide. The spindle is five inches in diameter American standard flanged nose type A-1. The motor is a two-speed, 5 and 2½ hp unit, and the transmission is of three-speed magnetic clutch design. Three interchangeable transmission output sheaves provide three ranges of six speeds each: 100 to 3000; 70 to 2100; and 50 to 1500 rpm. Single-point over-arm threading, air-operated collet chuck and bar feed equipment with up to 1¼-inch capacity and several arrangements of six-inch two and three jaw hand or air chucks are available. **Warner & Swasey Co.,** 5701 Carnegie Ave., Cleveland 3, Ohio.

Circle 421 on Page 19



Die Temperature Control

Compact cooling system controls temperature of water entering plastic molding machines to variations of less than ½ F. Its extremely small size (20 by 10 by 10½ inches) is made possible by a water pumping system that supplies high velocity, high volume water without the use of bulky reservoirs. Weight of the unit is 100 lbs. Circulating water can be quickly changed to higher or lower temperatures in 1 to 2 minutes by resetting a temperature dial. Operating temperatures from 40 to 250 F can be maintained. When furnished as a dolly-mounted unit, this temperature control device can be readily wheeled from machine to machine. Through the use of two dial thermometers which show temperatures of water entering and leaving the mold, operating efficiency can be checked at a glance. **Mokon Div., Protective Closures Co. Inc.,** 2207 Elmwood Ave., Buffalo 23, N. Y.

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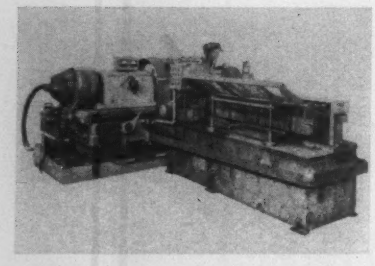

Double-Disc Grinder

Chain-feed, double-disc grinder can remove up to 5 cu in. of stock per minute. Feature of the chain-feed mechanism is its disappearing link principle which permits a variety of piecepart sizes to be fed into the machine without adjustment or change in the loading and feeding mechanism. Closely spaced drive links drop into neutral position when interference pressure from the piecepart is applied, leaving any free succeeding link to drive the part. On chain saw guides made of high-carbon steel, total stock removal of 0.015 inch is accomplished in a single pass on the grinder at a feed rate of 8 fpm. Size is held to 0.002 inch and parallelism, end to end or side to side, is held to 0.001 inch. A dial indicator shows when wheel wear approaches size limits. **Mattison Machine Works,** Rockford, Ill.

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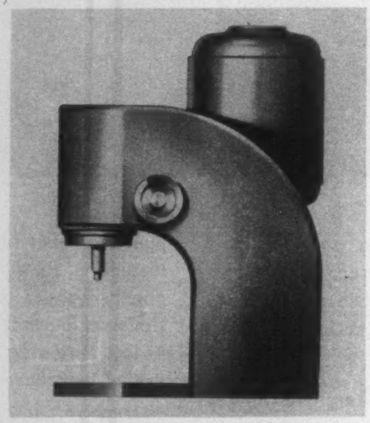

Portable Press

Machine is ideal for small assembly work and fabricating jobs. It is primarily an arbor press. Pressure range is from 50 to 1500 lbs. Stroke is 4 inches, ram diameter 1 inch, and throat 5½ inches. It weighs 150 lbs. Hydraulic power unit is built in. Press has a ¾ hp motor and plugs into any 110 v, 60 cycle current outlet. Synchronization with any machine tool or production line can be provided by means of automatic control features. To provide unlimited throat dimension, the press can be supplied without base but with mounting lugs for secure positioning where desired. **John S. Barnes Corp.,** 315 S. Madison St., Rockford, Ill.

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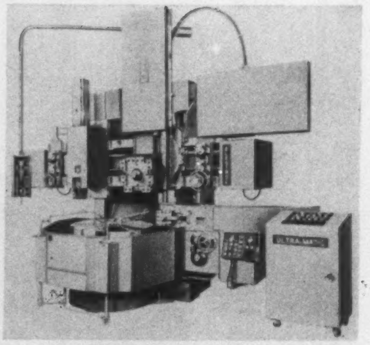

Boring and Turning Unit

Programming device, designated Ultramatic, which provides complete automatic control of a full cycle of machining operations is feature of 46-inch vertical boring and turning machine. The sequence of movements for each head on the machine is set up on an individual patchboard by means of jumper cords. The boards are then placed in the control console which contains the automatic electrical cycling controls. With patchboards and tools in place, stop blocks are set on vertical and horizontal rod assemblies which control the corresponding movements of each head. For producing a high degree of finish on contouring operations, the ram head on this machine can be equipped with a General Electric electronic tracer, providing two-dimensional 360-degree tracing operation. A machine equipped with this device has constant chip thickness control interlocked with the constant surface cutting control of the table. **Elmes/King Div., American Steel Foundries,** Cincinnati 29, Ohio.

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Circle 701 on Page 19→

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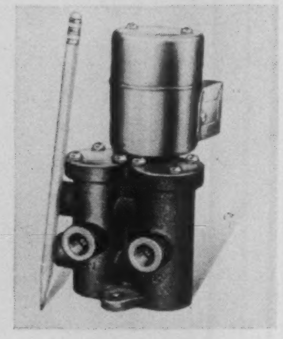
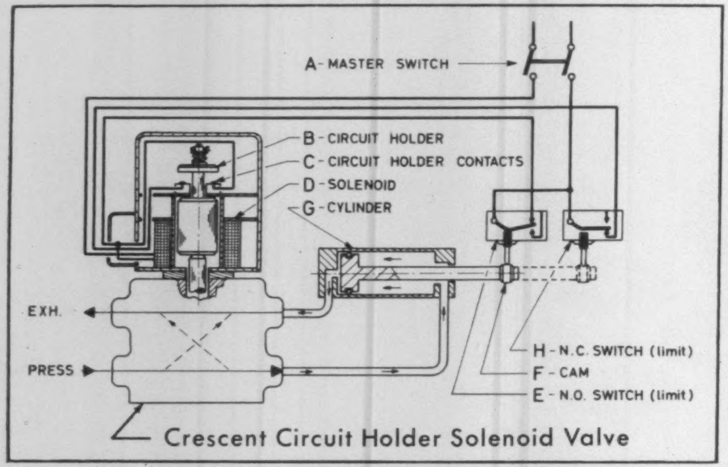
CRESCENT® CIRCUIT HOLDER SOLENOID VALVE



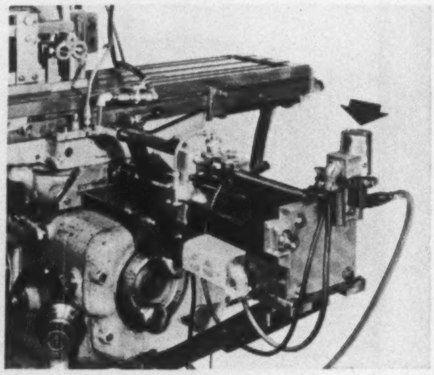
Compactness is an advantage of the unit.

to make cycling operations fail-safe

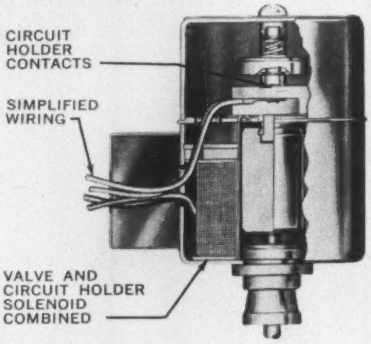
This new solenoid valve revises standards of circuit holder dependability on automatic cycling machines. Circuit holding action is performed by a specially designed, heavy duty solenoid (tested for 100-million cycle operation under conditions many times more severe than those encountered in any industrial application). Use of relays is unnecessary (see diagram), thereby eliminating one electrical circuit and avoiding an additional possible source of trouble. The Crescent Circuit Holder Solenoid Valve is applicable to automate machine tools, packaging machines, conveying machines, etc. Write for complete information and specifications (Bulletin No. 60809), or let a Barksdale representative demonstrate how Crescent Valves can save you money by cutting downtime.


A-MASTER SWITCH
B-CIRCUIT HOLDER
C-CIRCUIT HOLDER CONTACTS
D-SOLENOID
G-CYLINDER
EXH.
PRESS
H-N.C. SWITCH (limit)
F-CAM
E-N.O. SWITCH (limit)
Crescent Circuit Holder Solenoid Valve

In the starting position, the master switch is open, solenoid is de-energized and normally open switch is closed by cam. When master switch is thrown, the solenoid is energized. Air flow through the main valve is reversed and cylinder moves to extended position (dotted line). As cylinder rod moves, switch (E) opens; circuit holder (B) and switch (H) maintain the circuit. When rod is fully extended, cam opens switch (H), de-energizing the solenoid and reversing air flow. Piston returns to starting position. When cylinder rod is fully retracted, the solenoid is re-energized by closing of switch (E), and the cycle is repeated until the master switch is opened.



Typical installation of the new Crescent Circuit Holder Valve (arrow) on a milling machine set up for a boring operation.


CIRCUIT HOLDER CONTACTS
SIMPLIFIED WIRING
VALVE AND CIRCUIT HOLDER SOLENOID COMBINED

The valve solenoid, which is designed to outlast the life of the valve, performs the circuit holding function.

Fail-Safe • Dependable

Eliminates relays and relay enclosures

Simplifies wiring

Saves space

Reduces installation time

Cuts electricity costs

CONTROL VALVE DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle 702 on Page 19

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.

Air-Actuated Limit Switch

AIR-ACTUATED unit which permits the remote control operation of heavy duty limit switches has been developed by **R. B. Denison Manufacturing Co.**, 386 Broadway, Bedford, Ohio. This Loxswitch assembly, Part No. 2-1-1000, permits a limit switch to be mounted remotely where maximum protection can be provided against moisture, dirt, vibration, and heat, as well as at locations which will facilitate wiring and maintenance. This device requires no air valve or air switch. Actuation is provided by an orifice, 5/32 inch in diameter, which may frequently be built in existing equipment. Possible applications include the following: To provide a position indicator for a transfer bar or a fixture, to indicate the position of a guide bar or indexing shaft, to provide both a mechanical stop and an electrical interlock on an indexing table, to provide both mechanical stop and electrical stop for the lateral movement of a machine part, and to indicate the closing or opening of a press die or the location of a part therein. In operation, the unit, assembled to a limit switch, is supplied air at 40 to 80 lb pressure through an air inlet and inlet orifice. This air is allowed to escape through a bleeder line to a bleeder orifice. The closing of this bleeder orifice by any mechanical means allows the air to build up to line pressure in an air cylinder, which in turn operates the switch.

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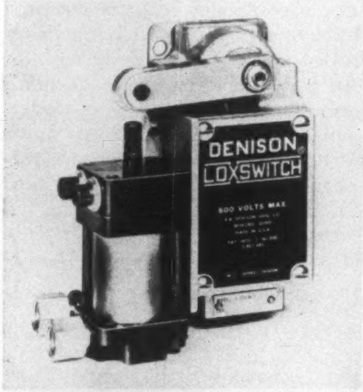
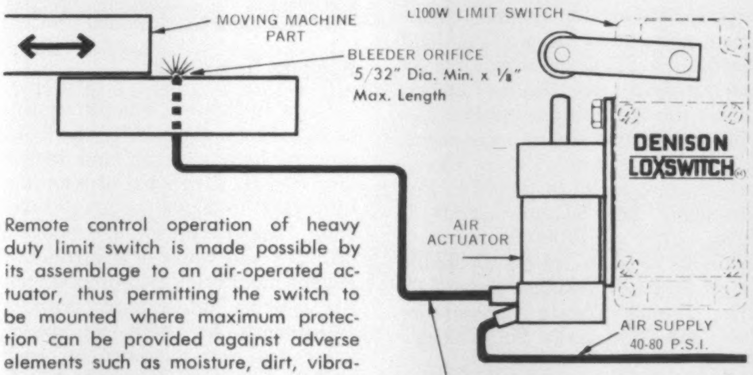
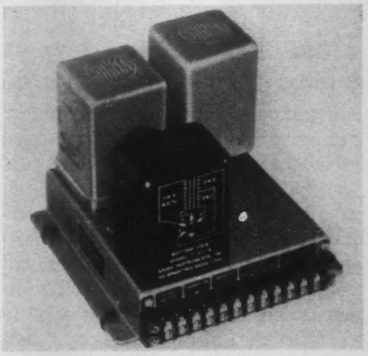


Air-actuated unit, assembled to a heavy duty limit switch, is supplied air at 40 to 80 psi. This air is allowed to escape through a bleeder line to a bleeder orifice. Blocking the orifice causes a pressure buildup that operates the cylinder, in turn operating the limit switch.


L100W LIMIT SWITCH
MOVING MACHINE PART
BLEEDER ORIFICE 5/32" Dia. Min. x 1/8" Max. Length
DENISON LOXSWITCH
AIR ACTUATOR
AIR SUPPLY 40-80 P.S.I.
BLEEDER LINE 3/8" I.D. Min. to Bleeder orifice

Remote control operation of heavy duty limit switch is made possible by its assemblage to an air-operated actuator, thus permitting the switch to be mounted where maximum protection can be provided against adverse elements such as moisture, dirt, vibration, and heat.



Temperature Control

Electromagnetic device consists of a magnetic amplifier relay, built-in dc power supply, and two legs of a bridge circuit. Unit is designed to monitor and control extremely small variations in temperature. When a thermistor and reference resistor are added to complete the bridge, the Series 8000 thermistor temperature control can detect temperature variations as small as 0.1C, depending on the thermistor chosen and the temperature range involved. In operation, the temperature change unbalances the bridge by changing the thermistor's resistance, thereby energizing the relay through the magnetic amplifier. The relay in turn can be used to switch various indicating, warning, or correction devices. Features of the device include resettable control; accurate remote control, even with long thermistor leads; and no contacts to lock. It is available in two models, the 8001 to switch one ampere loads and the 8002 with an additional slave relay to switch up to five amperes. **Sigma Instruments Inc.**, 185 Pearl St., South Braintree 85, Mass.

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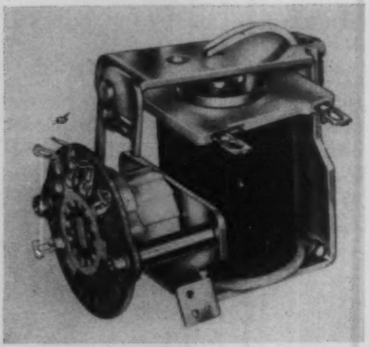

Stepping Switch

Unit is designed for sequence controlling, counting and totalizing, scanning, information storage, and other switching operations. It can be furnished with 2, 3, 4, 8, or 12 single pole continuous rotating contact for shorting or nonshorting steps. Available for all voltages up to 230 v ac, coil voltage range is from −15 per cent to +10 per cent of rated voltage. Nominal power is 20 volt-amperes ac minimum. The switch has an operating speed of 300 rpm. Rating is one ampere at 115 v ac, and insulation is tested at 1000 v, rms. **Comar Electric Co.**, 3349 W. Addison St., Chicago 18, Ill.

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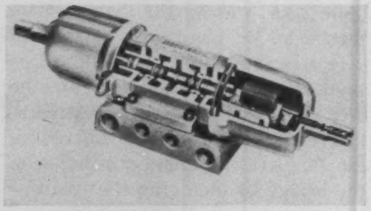

Air Valve

Three-position four-way air valve is a positioning valve that can "inch" an air-actuated device to any desired position and hold. Solenoid operated, it is available in either closed-center or open-center design, and operates at working pressures from vacuum to 150 psi. This three-position valve contains only three working parts: A spool and positive centering spring-loaded sleeves. Both Model 1063 (closed center) and Model 1073 (open center) come equipped with built-in manual operators. The ⅜-inch port size valve utilizes a prewired body and base with a plug-in feature that allows the valve body to be removed without disturbing any electrical wiring. When body is reassembled, connection is automatically made. **Mechanical Air Controls Inc.**, 10030 Capital Ave., Detroit 37, Mich.

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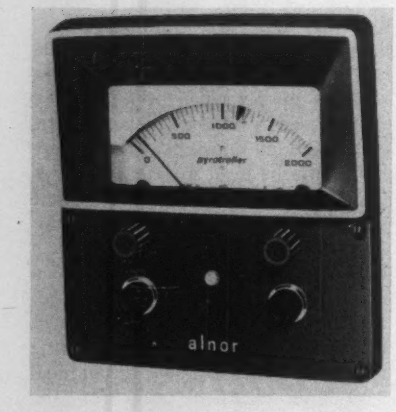

Temperature Controller

Applicable for use on ovens, heat treating furnaces, environmental test chambers, die casting machines, injection molding machines, extrusion presses, heat sealing machines, and processes requiring precise continuous control, On-Off controller unit is suitable for original equipment application as well as field application. Small space required by the instrument case, 6⅜ by 7 inches, makes the indicating controller useable as a panel board instrument. Pyrotroller is available in eleven ranges from 0-400 to 0-3000 F. Environment test chamber range is from −100 to +300 F. Unit is available in either single or double target models. **Alnor Instrument Co., Div., Illinois Testing Laboratories Inc.**, 418 N. LaSalle St., Chicago, 10, Ill.

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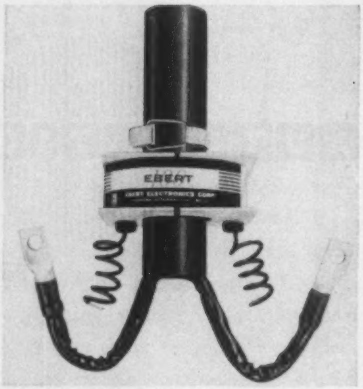

Mercury Plunger Relay

Device is capable of handling 100 amperes at 115 v ac. It is ideally suited for use in meter control, lighting control, heater power, furnace control, and for most high current applications. Feature of this mercury plunger relay is mercury-to-mercury contacts hermetically sealed and encapsulated in bakelite. An inert gas atmosphere quenches arcs for cool running operation. This relay is unaffected by dusty, dirty, moist, and corrosive atmospheres. **Ebert Electronics Corp.**, 212 30K Jamaica Ave., Queens Village, N. Y.

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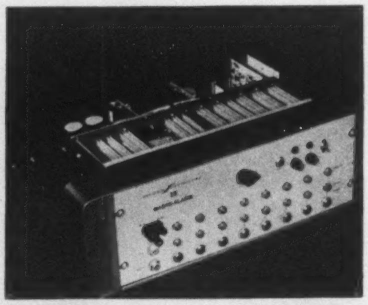

Alarm Scanner

Ultra high-speed, completely solid state alarm scanner for the scanning of both millivolt and higher level signals is capable of scanning from 1000 to 20,000 points per second. Applicable to temperature, pressure, and water flow in nuclear reactor monitoring and process control systems, this scanner provides adjustments for both the bogey value and the tolerance on each individual input. Visual and aud-

WHERE DO YOU STAND ON COMPUTER CONTROL— LEADING OR LAGGING?

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AUTOMATED BY GENERAL ELECTRIC

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GENERAL ELECTRIC

CPA-50 (9-60)

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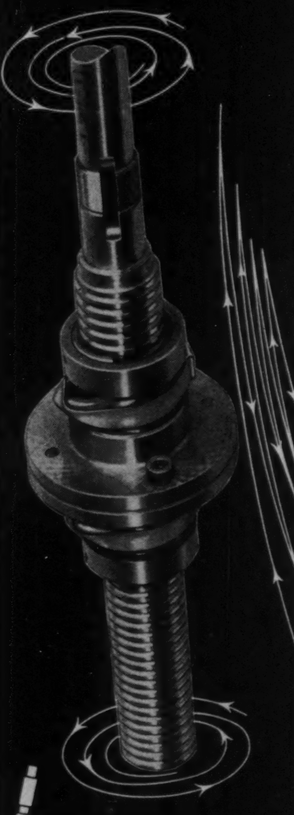
BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.



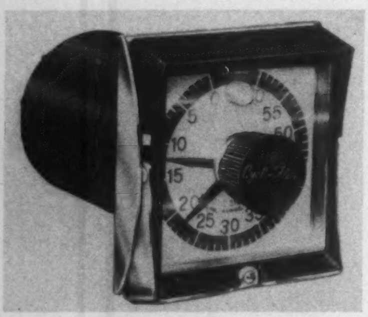
• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

Beaver Precision Products INC.
CLAWSON, MICH.

Circle 704 on Page 19

ible alarms can be provided, along with alarm point identification and memory. Designated the Magne-Alarm, this unit will accept inputs from thermocouples, strain gages, external voltages, or resistances, and provides a minimum of 130 db common mode rejection at 60 cps. Overload of one channel does not disturb the others. The input for each point, which consists of a winding on a magamp, is isolated from the other circuits within the alarm unit, and from the other inputs, thus providing a high degree of dc isolation. **San Diego Scientific Corp.**, 3434 Midway Drive, San Diego 10, Calif.

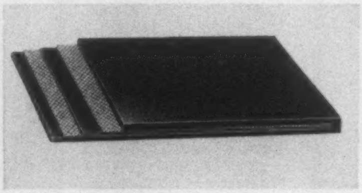
Circle 432 on Page 19



Reset Timer

Device contains four separate and independent load contacts, two of which are instantaneous and may be used as relays in a circuitry. Two others are time delay relay contacts which operate at the end of the time set on the dial. Each load contact, being separate and independent of the other, provides hundreds of practical control combinations. The two time delay relay contacts feature built-in adjustment to provide for an additional timed differential at the end of the time interval, if needed. This timed differential, or momentary pulse, is adjustable up to 1½ per cent of the total cycle. The Cycl-Flex 125 timer is furnished complete with its own plug-in case which is permanently mounted and wired to the application. Designed primarily for flush mounting, this case may be installed in a panel by cutting a 3⅛-inch diameter opening. The timer itself may be removed and replaced from the case at any time in 5 seconds or less. It features its own handle/lock to insure a positive dust and oil resistant seal. **Eagle Signal Co., Div., Gamewell Co., Subsidiary, E. W. Bliss Co.**, 202-20th St., Moline, Ill.

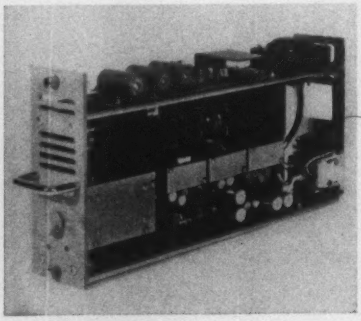
Circle 433 on Page 19



Conveyor Belting

Conveyor belt with hazard-proof carcass is a suitable remedy for many operating conditions that cause premature belt failure—including moisture, impact, fatigue, abrasion, chemicals, and acids. These belts, designated BostRon, combine a hazard-proof carcass feature with balanced belt construction (assuring equalized ply stress), and protect it with a Dulon cover. Troughing up to 45 degrees is permitted. Fastener rust, chemicals, or acids normally encountered will not affect these belts. Special belts can be used to solve the problems of conveying many corrosive materials. **Boston Woven Hose & Rubber Div., American Biltrite Rubber Co.**, P. O. Box 1071, Boston 3, Mass.

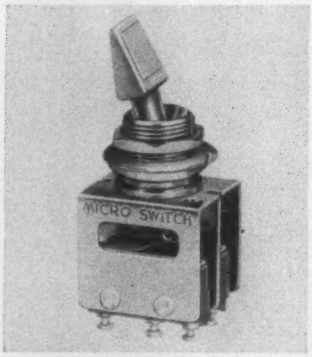
Circle 434 on Page 19



DC Amplifier

Floating differential dc amplifier provides complete isolation of input signal from amplifier output and chassis ground Designed specifically for amplification of dc signals from strain gages, thermocouples, and bridge type transducers, Model 1-104 offers common mode rejection of 180 db at dc, 130 db at 60 cycles with up to 1000 ohms line unbalance. Stability is 5 microvolts over a six month period. Operation of the amplifier centers around modulating the input signal with a 400 cycle electromechanical chopper, whose output is transformer-coupled into an ac amplifier. This output is then transformer-coupled into two identical ring demodulators—one provides dc feedback and one provides the dc amplifier output. By use of a simplified low gain operational amplifier, unnecessary complex circuitry is eliminated and high voltage output with low output impedance (1 ohm maximum) is assured. **Neff Instrument Corp.**, 2211 E. Foothill Blvd., Pasadena, Calif.

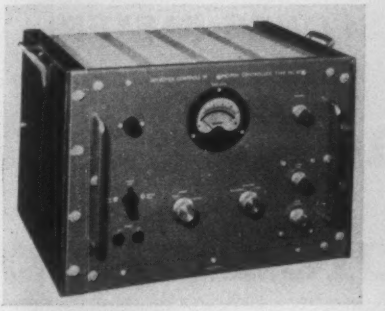
Circle 435 on Page 19



Toggle Switches

Compact toggle switches, featuring bright aluminum tabs that provide instant position indication, are ideally suited for electronic equipment, data processing systems, industrial consoles, and other areas where accurate, long-life switches are needed. Series 400 switches are available in both momentary and maintained-contact versions. Each toggle operates two precision snap-action switches encased in a plastic cover. Each switch has two isolated single-pole double-throw circuits, UL listed at 5 amperes, 125 or 250 v. The switches have turret terminals for soldered or solderless connections. Dry-circuit switches are available to handle low-energy circuits. Other variations include dull black tabs, sealed environment-free snap-action switches, and panel and bushing seals. **Micro Switch Div., Minneapolis - Honeywell Regulator Co.**, Freeport, Ill.

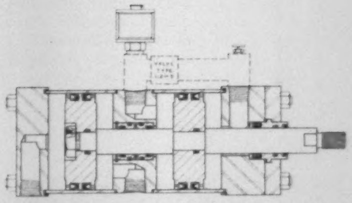
Circle 436 on Page 19



Motor Controller

High precision speed control system with a maximum output of 0.5 hp is suitable for a wide variety of jobs in scientific research and engineering. System includes a motor with a maximum speed of 7500 rpm, forwards or backwards, whose speed can be smoothly varied down to zero. Model MC.47 provides a speed range of 1000:1 and a speed stability approaching 0.1 per cent. Where the application calls for a high resistance to torque changes, a flywheel can be supplied. With the flywheel fitted, the acceleration is 1000 rpm per second and the *droop* on applications of full load is about 10 rpm. With the flywheel removed, the machine accelerates faster, 7000 rpm per second, but as the amplifier gain is reduced, the *droop* with full load application is up to 30 rpm. Maximum torque of the controller is 66 ounce inches, constant over range; and stability is ±2 rpm, hour to hour, on constant load. Coarse and fine controls on the front panel may be substituted for speed control from a remote potential. **Servomex Controls Ltd.**, Crowborough, Sussex, England.

Circle 437 on Page 19



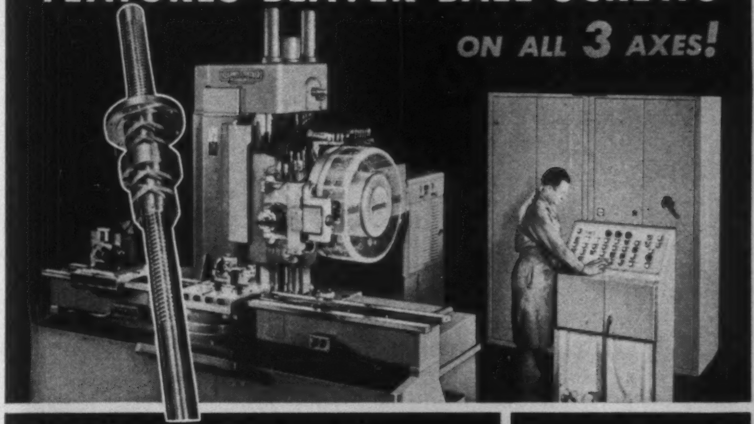
Air/Hydraulic Cylinder

Unit contains an air piston and a hydraulic piston mounted on a single rod. Cylinder is operated with air pressure; self contained and

K & T'S MILWAUKEE-MATIC
TAPE-CONTROLLED MACHINING CENTER
FEATURES BEAVER BALL SCREWS
ON ALL 3 AXES!

A significant machine tool achievement—Milwaukee-matic numerically controls positioning, tool selection, indexing, machining, speeds and feeds. Preloaded Beaver Ball Screws with the inherent precision, essential in data control, were the choice of Kearney & Trecker designers for spindle positioning, cross feed and table feed—just as they are with most builders of numerically controlled machines.
Our engineers will be glad to work with you.

Beaver Precision Products INC.
CLAWSON, MICH.

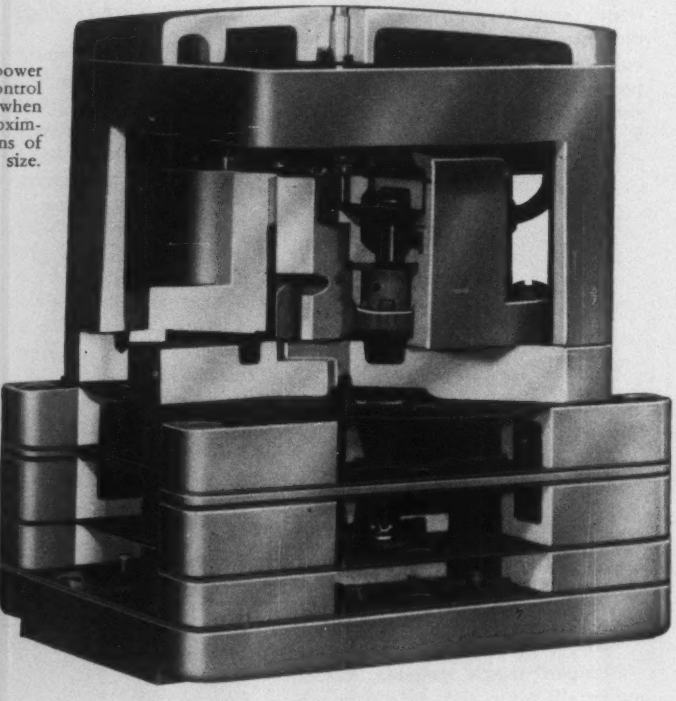


Circle 705 on Page 19

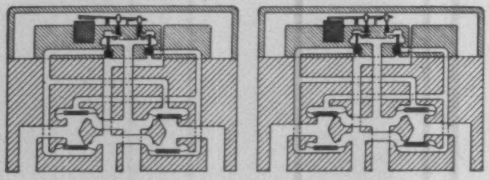
IT CUTS COSTS! RESPONDS FASTER!

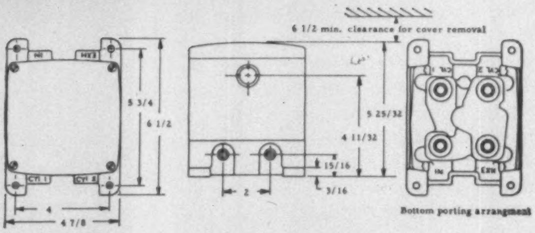
Honeywell announces trouble-free pneumatic

An entirely new concept in pneumatic power amplification. Provides accurate, instant control of pneumatically operated power cylinders when coupled with manual, cam-operated, or proximity switches. Available in 48 combinations of action, coil voltage, port location and size.



One power head is adaptable to all types and many sizes of valves. Shown here is the ½" model; above is the ¼", illustrating how a change of manifolds permits various valve sizes.





Bottom porting arrangement

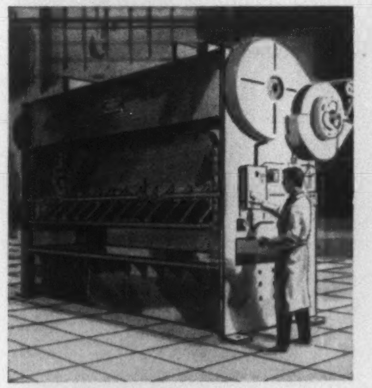
Fig. 1 - 1/4 in. model dimensions

Only Honeywell offers these time and money-saving features!

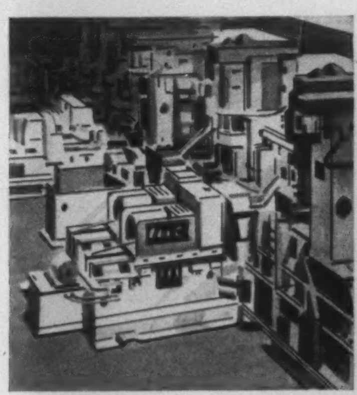
- **Completely flexible design**—the same power head is used for all valve sizes. Choice of many porting arrangements. Reversible power head.
- **Long life**—⅜" and ½" models built to operate in excess of 20 million cycles—¼" size in excess of 40 million cycles!
- **Maintenance-free.** No preventive maintenance required up to 20 million cycles. No lubricator, no filter needed.
- **Fast response—high capacity**—can be cycled up to 1000 CPM on and off cycles with 80% dumping into 12 cu. inches. One cycle takes only .00005 cfm. Fast sequencing—immediate response.
- **JIC** Built to JIC standards, captive screws, chained cover, and fail-safe. Inoperative with cover removed. Manual operator.
- **Lowest power consumption** of any valve available. Recognizes minimum electrical signal. One va.

the most flexible valve of its kind!

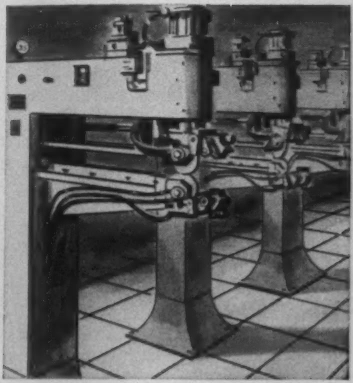
One power head adapts to all types and many sizes of machine tool valves . . . operates over 40 million cycles without preventive maintenance



Fast response and long life of more than 40 million cycles solve two of the biggest problems in press operations.



Little or no maintenance or lubrication required makes this new valve ideal on transfer machines where dependability is important.



Chamber coil is guaranteed not to burn out, even when subjected to prolonged stalled positions as in welding operations.

Compare, and you'll find that here at last is a valve built to give service, rather than to be serviced. Compare, and you'll find this the most *adaptable* pneumatic valve ever designed for transfer line, punch press and welding machine operations.

Never again will you have to disassemble pipes and fittings to change a valve. A change of manifolds permits either ¼″, ⅜″ or ½″ valve sizes—makes it a 3-way or 4-way valve. Reverse the power head and you change it from a reverse to a direct-acting valve. Even the porting arrangements can be changed—bottom-side, side-bottom, and similar positions. And because one power head is adaptable to all types and many sizes of valves, you can hold your stock of repair valves to a minimum. Coils are available to work directly from static switching circuits.

And consider these added advantages. You get fast response, high capacity, lowest power consumption—all at lowest cost, with little or no maintenance required. Extremely rugged shockproof construction, oil- and moisture-proof seals, lightweight and compact size make this valve adaptable to almost any mounting location. All this, plus a durable oxidized finish which can be painted any color if a change is necessary.

For long, trouble-free service and money-saving features, you'll find that no other valve compares with Honeywell's new V4032A, B & V4033A. For more details, call your local Honeywell office; or write: Minneapolis-Honeywell, Minneapolis 8, Minnesota, and ask for Form No. 95-2597.

75th YEAR
PIONEERING THE FUTURE

Honeywell

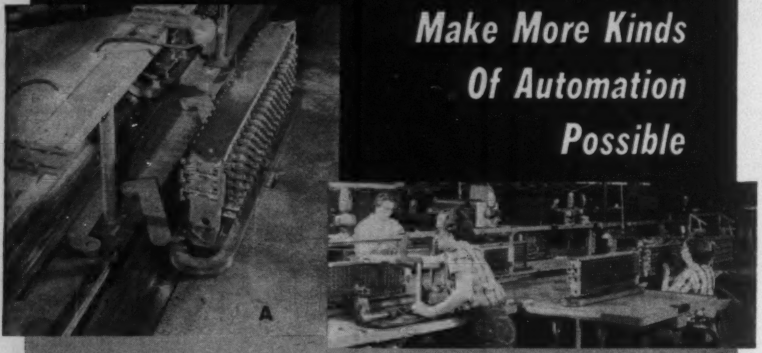
H HONEYWELL *First in Control*
SINCE 1885

Circle 706 on Page 19

SANDVIK

STEEL BELT CONVEYORS

Make More Kinds Of Automation Possible



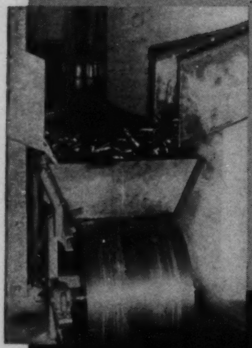
At Western Electric's Omaha Works, Sandvik "Tru-Track" steel belt conveyors 130' and 150' long are used in assembly tables for crossbar switches. These switches weigh up to 57 pounds and are mounted on roller carriages for rolling on and off the moving steel belt. Photo (A) shows how pneumatically-operated pusher arms move carriage off belt at each work station. Pushers are actuated by a limit switch tripped by a removable magnet on top of unit.

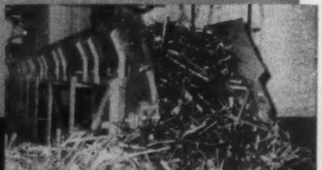
The inherent abilities of the solid, cold rolled carbon steel band used on Sandvik conveyors open the way to new automated operations.

The smooth, hard, impervious surface of the flat steel belt:

- Resists Oil, Heat and Abrasion
- Simplifies Automatic On-Off Sliding and Live Backlogging
- Can Be Easily Fitted With Simple Guide and Discharge Devices
- Has High Load Capacity and Long Service Life
- Belt Can Be Any Length

Sandvik "Tru-Track" steel belt conveyor handling metal scrap. Accurate, straight-line tracking of belt combined with angled side plates prevents pieces from getting wedged between side plates and belt . . . thus making automated operation possible.





SANDVIK STEEL BELT CONVEYORS

SANDVIK STEEL, INC.

Steel Belt Conveyor Department
1702 Nevins Rd., Fair Lawn, N. J. SWarthmore 7-6200
Cleveland • Chicago • Detroit • Los Angeles
IN CANADA: Sandvik Canadian Ltd., P.O. Dr. 1335, Sta. O., Montreal 9, P.Q.

Circle 707 on Page 19

sealed hydraulic unit gives the speed control of a hydraulic cylinder using low pressure air. The stroke can be controlled on both forward and return strokes or on either stroke with quick return. Series AD is available with three valve types: Controlled speed of forward and return strokes, controlled speed of forward or return stroke with quick return of alternate stroke, and variable controlled speed of forward and return strokes. This Airdraulic cylinder can be used to activate: Machine tool tables, feed and traverse of single and multiple tools, drilling heads, and other work heads, indexing devices, fixture and clamping devices, shearing and swaging machines, electric welding equipment, and material handling equipment. It comes in a range of sizes, 1½ through 10-inch bores. Various mounting styles are available. **Lynair Inc.**, Dept. A-D, 3100 E. Michigan Ave., Jackson, Mich.

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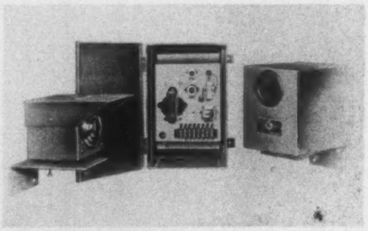

Photoelectric Relay

Highly sensitive, photoelectric relay line can be use in atmospheres dense with foreign matter and where an extraneous light source could cause false operation in a conventional unit. Typical uses include door control, conveyor control, and intrusion alarms. The relay can be used in the presence of paint spray and to detect the position of parts in ovens, kilns, or furnaces. Model PL for operating at distances up to 2000 feet, and Model PLJ for operating distances under 100 feet comprise this line of relays. The modulated signal beam of the relay cannot be affected by other light sources. The signal beam must be completely broken to operate the relay. Dust, fog, ice, and snow will not affect operation. Relay output is thyratron controlled. A 0.1 second interruption of the signal beam will operate the relay. Maximum operat-

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DENISON HydrOILics

DENISON Multipress installation pays off for BARBER-COLMAN with faster, simplified small motor assembly that...

CUTS COSTS

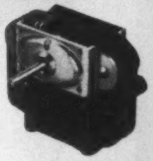
PREDICTED cost cuts have been *confirmed* by the installation of three Denison Multipresses at Barber-Colman Company in Rockford, Illinois.

Justified by MAPI (Machinery and Allied Products Institute) formula analysis, these presses operate in a line connected by belt conveyors. Semi-automatically, Multipresses perform bending, staking, aligning, compressing, riveting and stamping operations in the production and assembly of small precision electric motors.

In addition to more efficient handling of production functions, other Multipress *bonus benefits* include—product uniformity... reduced scrap loss...rapidly adjustable stroke length and pressure for faster, simpler set-up...longer die life to lower tooling costs and downtime.

Duplicate these savings and bonus benefits in your plant today! Your Denison Production Specialist can show you how with a **M**ultipress **A**nalysis **P**rogram that can **MAP** new savings for you now.

DENISON 4-TON HYDRAULIC MULTIPRESS *is used by Barber-Colman to assemble low-cost precision AC motors.*



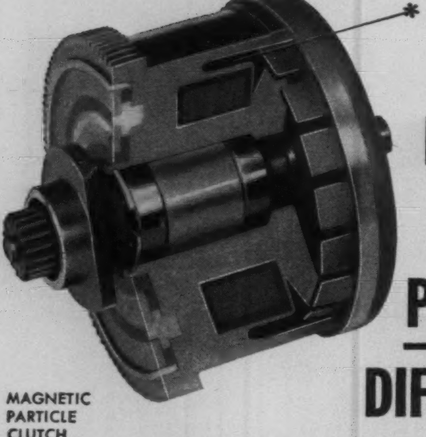
DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1234 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON

HYDRAULIC MULTIPRESS

Circle 708 on Page 19


MORE THAN A PARTICLE OF DIFFERENCE

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CLUTCH

*Lear patented magnetic-particle mixtures are totally dry—which means no leaking, no packing; have more proportional shear strength; provide a faster, more predictable response; and protect clutch surfaces from wear during slipping conditions. Lear has more, application-proven clutches—designed for high-response servo systems and other intermittent load operations—than any other manufacturer. Ask about the one best suited to your needs.

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ELECTRO-MECHANICAL DIVISION 110 Ionia Avenue, N.W., Grand Rapids, Michigan

Circle 709 on Page 19

MOLINE

No. HD68 Special

Multiple-Spindle Machine with 81" clearance between columns, drills, reams and chamfers holes in tube sheets of various sizes Electric control provides means for determining hole pattern through selection of in-line spindles and control of two-way, positive-positioned hydraulic indexing work table.

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- Straight Line Multi-Drilling
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REPRESENTATIVES IN PRINCIPAL CITIES

107

Circle 710 on Page 19

ing rate is 600 operations per minute. **Clark Controller Co.,** 1146 E. 152nd St., Cleveland 10, Ohio.

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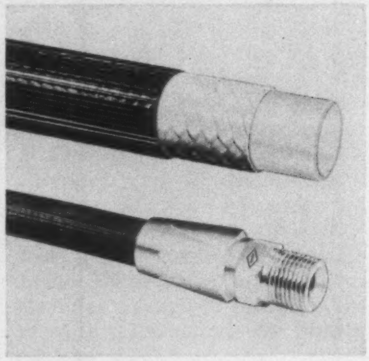

Hydraulic Hose

Polyamide-polyester hose has been developed for hydraulic and other high pressure applications. It has a special polyamide inner tube with a high tensile strength polyester braid reinforcement and an abrasion resistant polyamide cover. This hose is capable of withstanding burst pressures comparable to SAE 100-R1 wire braid hose. It provides superior flex-impulse strength and resistance to abrasion and offers smaller OD for equivalent pressure and ID size. It is nonaging, available in long lengths, and is not affected by nonflammable hydraulic fluids to 200 F and flammable fluids to 225 F. It is also available with reusable and permanently attached couplings. **Imperial Brass Mfg. Co.,** 6300 W. Howard St., Chicago 48, Ill.

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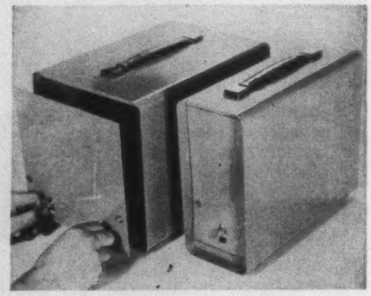
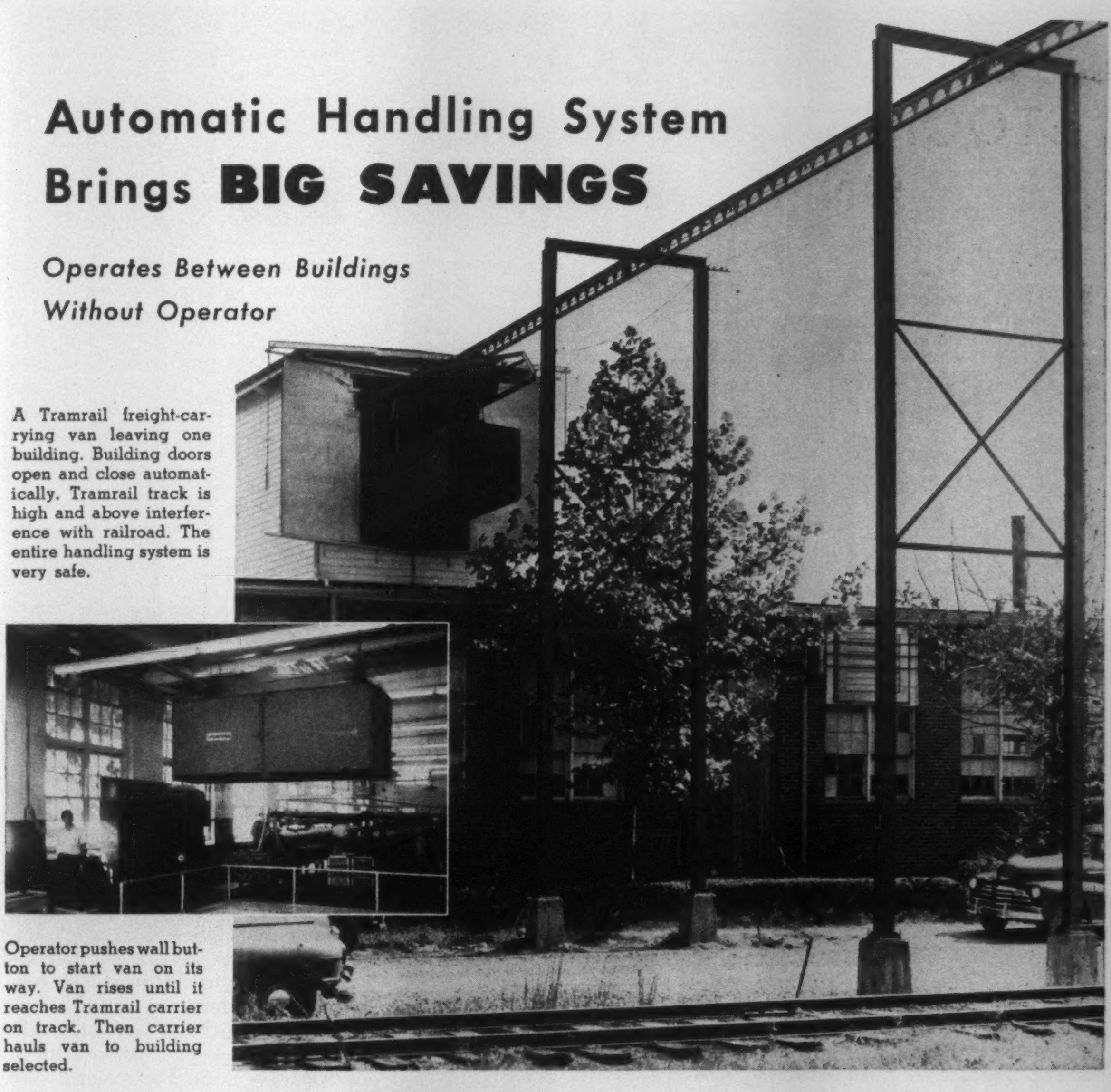


Instrumentation Case

Pre-engineered instrument cases are designed for use as receptacles for test instruments or as carrying

Automatic Handling System Brings **BIG SAVINGS**

Operates Between Buildings Without Operator



A Tramrail freight-carrying van leaving one building. Building doors open and close automatically. Tramrail track is high and above interference with railroad. The entire handling system is very safe.

Operator pushes wall button to start van on its way. Van rises until it reaches Tramrail carrier on track. Then carrier hauls van to building selected.

RAIN or shine, this Cleveland Tramrail system works without complaint. Inclement weather is of no concern, because no one has to go outside to operate this system.

The Tramrail freight-carrying van travels between buildings as directed by the touch of a pushbutton. It goes up and down grades and handles materials between different floor levels.

No regular operator is needed for this type of system. Usually the time required to dispatch loads is so little that production workers can do this along with their normal duties.

Great savings are made with Cleveland Tramrail automatic handling systems. They cut handling time enormously. They operate overhead above usual floor traffic and hindrances. They save floor space. They eliminate expensive floor repairs which floor conveyances make necessary. Tramrail equipment requires far less maintenance than usually is necessary with other types of conveying equipment.

Because the dividends are large and immediate when you install a Cleveland Tramrail automatic handling system, it will be to your interest to get the facts on what Cleveland Tramrail engineers can do for you.

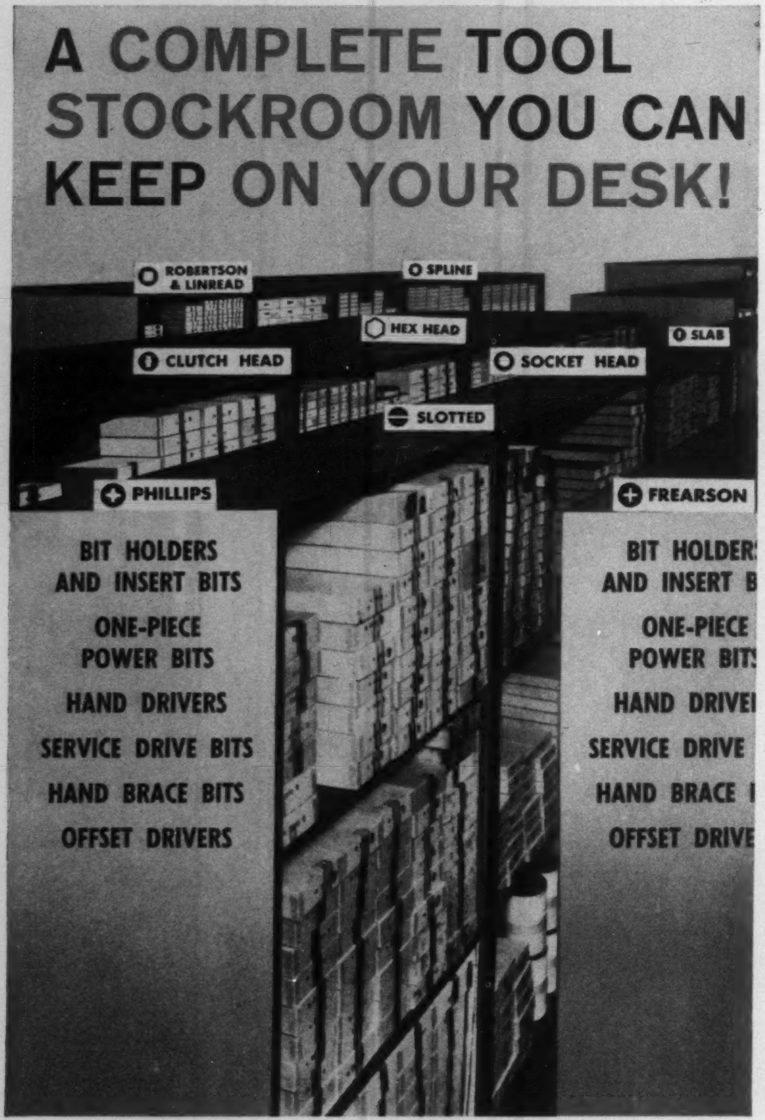
CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

Write for free "Automatic Handling" booklet.

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1335 E. 290 ST. • WICKLIFFE, OHIO

Circle 711 on Page 19



As quickly as turning a catalog page, you can order out any of the thousands of Apex screwdriving tools in this stockroom. Standard and magnetic tools . . . for all types and sizes of screws . . . for manual or power tool operation . . . they're all clearly listed in our Catalog 30-C.

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APEX FASTENING TOOLS

SCREWDRIVING • NUT RUNNING • SPECIAL

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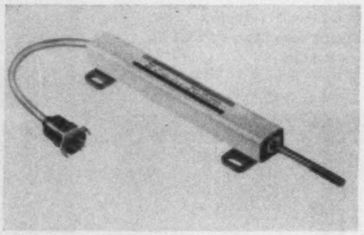
Circle 712 on Page 19

and shipping cases for plug-in replacement chassis. A chassis is quickly locked in or removed by a half turn of a convenient cam lock. Open-sided chassis permits use of snap-in terminal cards mounted in vertical planes of circuitry. All leads are brought to an accessible point-of-check that can be graphically identified with circuit legends. Functional hooded styling protects indicating lights, dials, switches, etc. mounted on the front panel. These cases are of baked enamel finish, and available in 2, 4, and 8-inch widths. They have a height of 10 inches. **Alden Products Co.,** IC-7 N. Main St., Brockton, Mass.

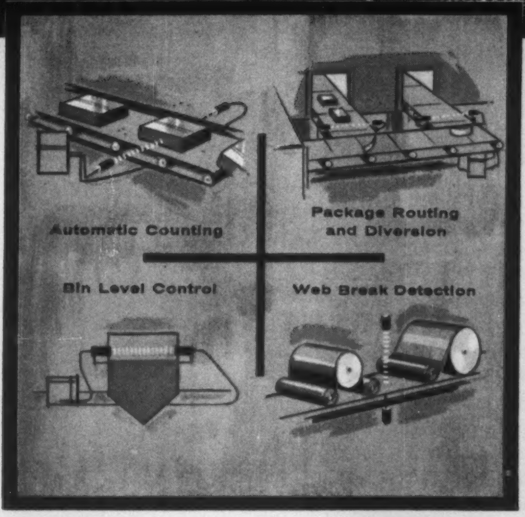
Circle 441 on Page 19



Linear Transducer

Instruments are designed to detect the position of hydraulic actuators, pneumatic valves, positioning mechanisms, and linkage components. They provide precision electrical signals proportional to mechanical position for recording, control, and telemetering circuits. Model 156 Align-O-Pot features a self-aligning shaft that permits measurement of linear displacement even when perfect alignment with the actuating member is impossible. The floating shaft is securely connected to the wiper assembly which is internally supported through the entire length of travel. Model 155 Liniometer (illustrated) is a companion model, available for applications not requiring the self-aligning shaft feature. A rigid bushing-supported shaft which does not need lubrication for the life of the instrument replaces the floating shaft. Specifications for both models are as follows: Travel, 0-1.5 to 0-6.5 inches; resistance, 1 to 50 K ohms; resolution, as low as 0.001 inch; linearity, ±0.5 per cent; operating temperature range, −55 to +175 C; power rating, 1.0 w per

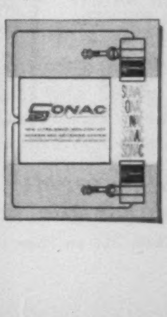
a new
dimension
in automated
controls
SONAC
ULTRASONIC SENSOR
Model Number
PATENT PENDING
DELAVAN
Manufacturing Company
WEST DES MOINES, IOWA
SONAC
SONAC
Patents Pending


Automatic Counting
Package Routing and Diversion
Bin Level Control
Web Break Detection

SONAC ULTRASONIC, NON-CONTACT SENSING AND SWITCHING SYSTEM

Before Sonac, sensing and switching control systems which involved breaking a beam of energy were limited by vibration, dust, smoke, steam, air contamination and too much or too little light. Sonac's ultrasonic energy "beam" is completely free of these limitations. The acoustic lens on Sonac sensors can actually be painted without affecting performance. Utilizing high frequency sound also means there are no lamps to burn out. Savings in replacement parts and maintenance time often means Sonac pays for itself. Sonac is completely transistorized, providing you with a rugged, dependable electronic circuit.

These are just a few of Sonac's many uses. Optional equipment includes reflectors for precision beam and positioning control, and coupler assemblies for use with flexible tubing for remote sensor locations. This descriptive booklet will be sent to you on request.



DELAVAN
Manufacturing Company
WEST DES MOINES • IOWA

Circle 713 on Page 19

inch of coil at 40 C; and life expectancy, 1,000,000 cycles. These potentiometers will withstand abusive high frequency shaft movement, acceleration to 100 g, and vibration levels up to 25 g at 2000 cps. **Bourns Inc.**, 6135 Magnolia Ave., Riverside, Calif.

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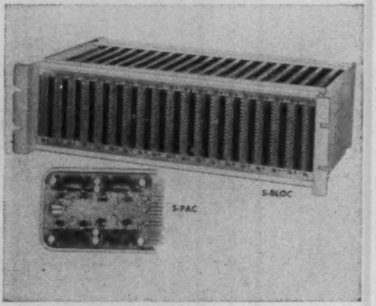

Digital Modules

Series of plug-in high speed digital modules are ideal for digital systems where high volumetric efficiency is required. Series S, featuring NAND circuits operates in the frequency range from dc to one megacycle. Features of this series include glass epoxy cards (4½ by 7 inches), etched circuit, anodized aluminum frames, and ultra-reliable 34 pin connectors (choice of solder or taper pin). The complete S-PAC Series will consist of approximately 25 different package types plus complementary hardware. The following items are available: Gating package (4 two-input gates plus additional diode clusters), diode clusters, flip-flop (4 independent flip-flops with dc inputs), counter (4 independent flip-flops with complementing and dc inputs; may be wired to count straight binary or binary coded decimal), power amplifier (4 independent power amplifiers), and 4 different S-BLOC's (choice of solder or taper pin connectors and 19 or 28 PACs per BLOC). **Computer Control Co. Inc.**, 983 Concord St., Framingham, Mass.

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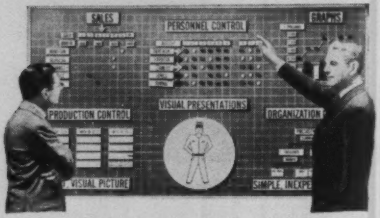
VISUAL
MAGNETIC
CONTROL



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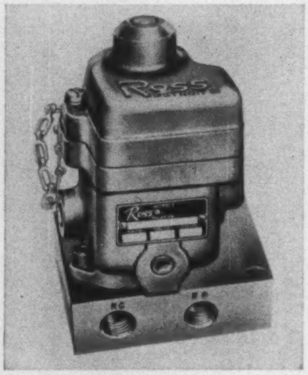
Circle 714 on Page 19

Numerical Control System

Control system is capable of an electronic resolution of 0.000010 inch. With this resolution, the unit can position a jig borer table, for example, to tolerances of less than 0.0001 inch within the range of typical table travel. Motion is simultaneous in both axes. Mechanical tape reader of the Dyna-Point-20 uses standard 8-channel binary coded decimal paper or plastic tape. Ten auxiliary functions may be programmed in addition to dimensional data, using standard Flexowriter codes. Dial input switches allow manual positioning of the workpiece to the nearest ten thousandth of an inch. Zero offset feature simplifies setup by permitting the initial reference point to be located on the work rather than on the table. **Bendix Corp.** Industrial Controls Section, 21820 Wyoming Ave., Detroit 37, Mich.

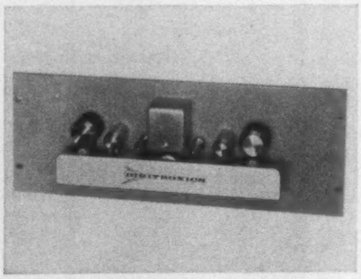
Circle 444 on Page 19



Solenoid Valve

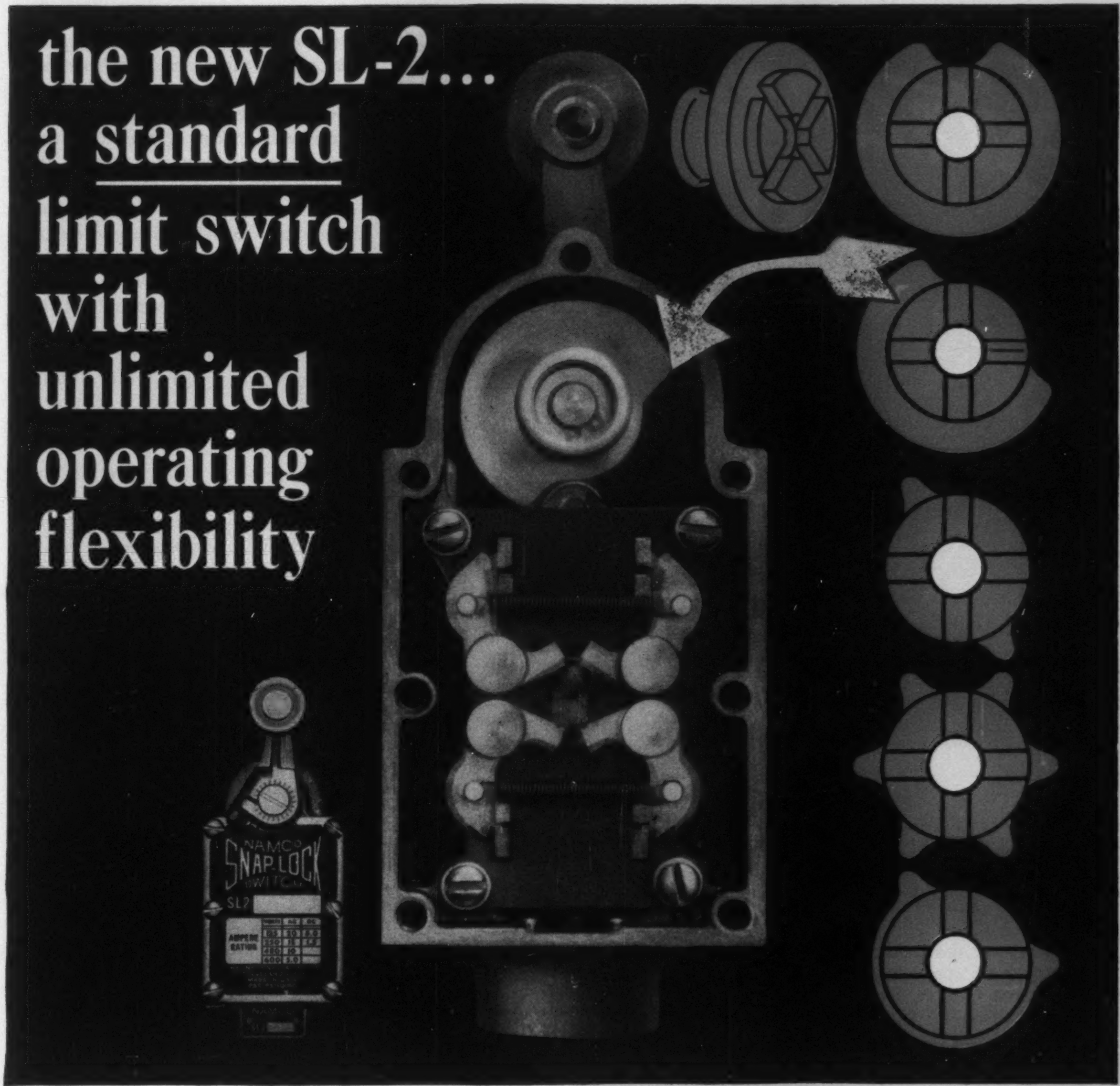
Features of this light weight air valve, designated the Pacer, include cycling in excess of 1000 cpm; 5/32 inch minimal internal orifice (N.C. side); solenoid that requires only 7 w of power; short poppet travel; dust and liquid-tight seal; light weight (28 oz) with cast aluminum body, and integral wiring space. Valve is designed to JIC. standards and is available as either a three or four-way unit. The four-way unit handles an air service range of 15 to 150 psig. Pipe sizes accommodated are ⅛ and ¼ inch. **Ross Operating Valve Co.**, 120 E. Golden Gate Ave., Detroit 3, Mich.

Circle 445 on Page 19



Tape Strip Reader

Unit senses tape perforations by means of silicon photodiodes which are set permanently in the head, with the diode lens protruding. This



the new SL-2... a standard limit switch with unlimited operating flexibility

Tailor limit switch performance to your specific job with NAMCO'S *standard* SL-2. This "machine life" limit switch features a standard cam blank which can be cut into a wide variety of configurations to meet any application. These interchangeable cams provide positive control of contact sequence; let you match switch operation to your specific job. Ruggedly built, oil-tight and moisture-proof, the SL-2 provides dependable, accurate performance that meets your most precise requirements.

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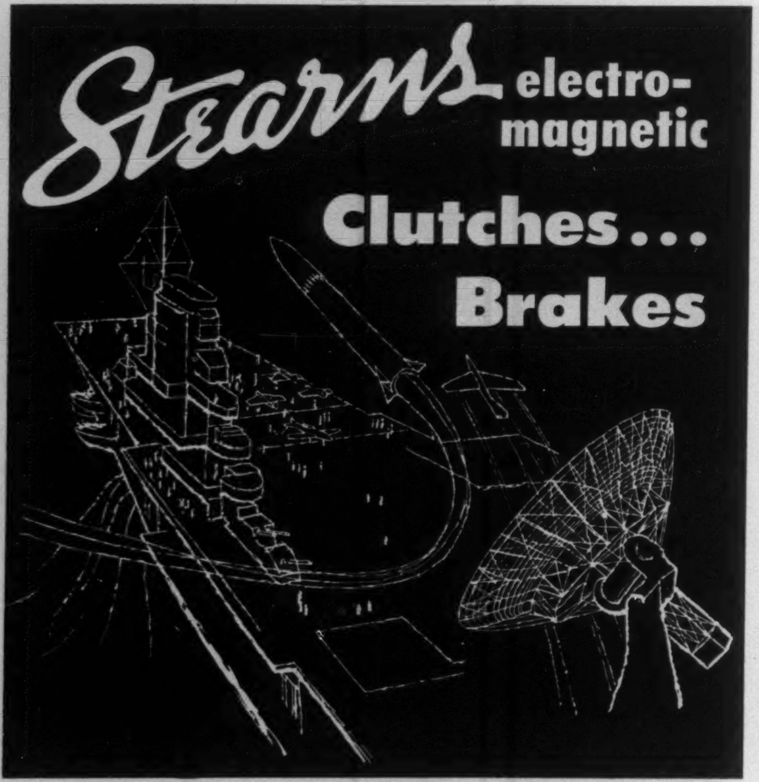

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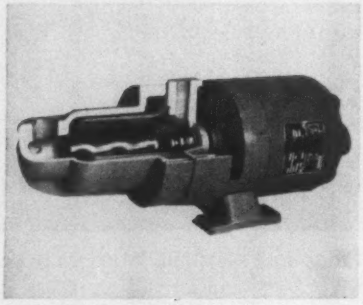
Circle 716 on Page 19

bi-directional high speed perforated tape reader operates on loops or strips of tape. A bi-directional spooler is available at speeds up to 300 characters per second, with 8-inch reels. Part of the completely transistorized circuits are two flip-flops which provide reliable control of the four solenoids used to control start and stop in either direction. Model B3500 enables high-speed search and then reverse to the beginning of the block which can then be read in its entirety. Reader includes a sprocket reading head, power supply, gating and shaping circuits, and amplifiers. For reading 5, 6, 7, or 8 level tape a variable tape guide is adjustable to three positions. The innermost position is used for 11/16 inch (Teletype) tape; pulling the guide out to a middle position sets it for 7/8 inch (6 or 7 level) tape; the outermost position adjusts for 1 inch or 8 channel tape. Printed circuit modules are designed so that outputs consistent with PNP transistor circuits are standard and output for NPN circuits are available as an optional feature. **Dykor Tape Reader Div., Digitronics Corp.,** Albertson Avenue, Albertson, L. I., N. Y.

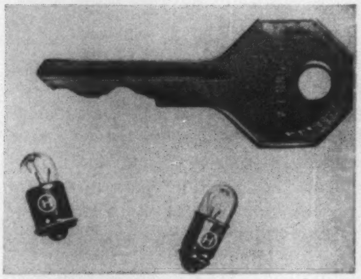
Circle 446 on Page 19



Coolant Pumps

Designated Pres Sure Kool pumps, these units use the Moyno principle for positive delivery of coolants at one or more constant pressures. This simple principle of an abrasion resistant helical screw rotor turning in a stator is time-tested and has proven effective for positive displacement in pumping heavily contaminated coolants and cutting oils. The pumps are especially useful in handling of these heavy, contaminated fluids, particularly where suction or pressures are demanded. They can be mounted on a machine either vertically or horizontally with suction line piped to coolant tank. Motorless units may be powered by drive shaft or separate motor serving a dual function. **Associated Engineers Inc.**, P. O. Box 1628, Springfield, Mass.

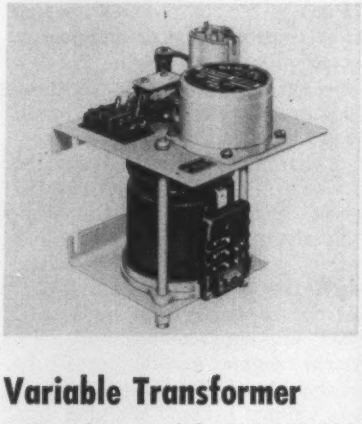
Circle 447 on Page 19



Incandescent Lamps

Subminiature incandescent lamps vary in size from ½ inch over-all length with voltages ranging from 1.4 to 28 volts. They have been designed for applications in the aircraft instrument field and wherever miniature sources of light can be used to advantage, such as in indicator and pilot lights, instruments of all kinds, and electronic devices. The lamps are manufactured for high electrical performance, and long life under the severest conditions of vibration and shock. **Hudson Lamp Co.**, 528 Elm St., Kearny, N. J.

Circle 448 on Page 19

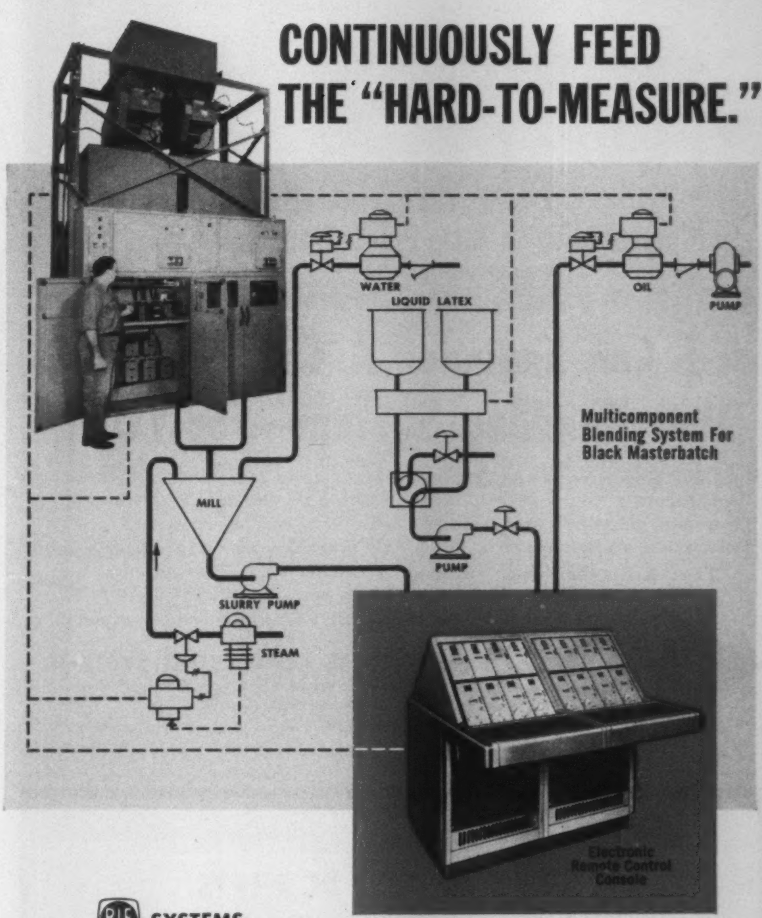


Variable Transformer

Transformers of the 116, 117, 216, 217, 126, and 226 Series in both open (shown) and enclosed construction are available with motor-

POSITIVE CONTROL OF *MATERIALS IN MOTION* B-I-F METERS FEEDERS CONTROLS

CONTINUOUSLY FEED THE "HARD-TO-MEASURE."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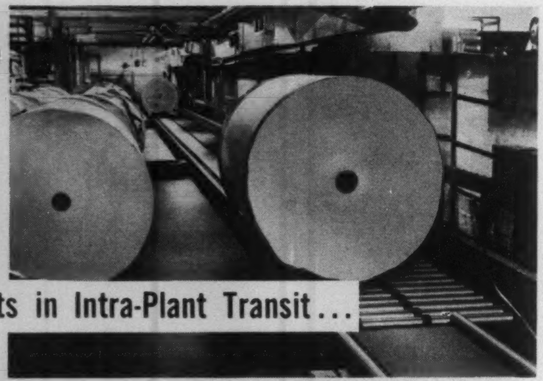
Circle 717 on Page 19



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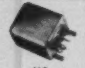
Circle 718 on Page 19

ELGIN ADVANCE RELAYS

*HERMETICALLY SEALED**
MILITARY DC RELAYS
AVAILABLE FROM STOCK

SERIES	MV Crystal Can Size	VGS Miniature Sensitive Rotary	 VG Miniature Rotary	MQA Printed Circuit Crystal Can Size	NM Subminiature Transistor Can Size	SO Miniature Sensitive
CONTACT ARRANGEMENT	DPDT (2 form C)	DPDT (2 form C)	DPDT (2 form C)	DPDT (2 form C)	SPDT (1 form C)	SPDT (1 form C)
RESISTIVE CONTACT RATING (AMPS)	2	5	5	2	0.25	1.5
COIL** RESISTANCE RANGE (OHMS)	30-7000	120, 500, 2000	25, 100, 500	35-9100	50-2000	1000-10,000
OPERATING POWER AT 25°C (MW)	250	100	340	250	100	40
DIMENSIONS (IN.)	0.875x 0.797x 0.359	1.125x 0.875x 0.875	1.125x 0.875x 0.875	0.875x 0.800x 0.396	0.530x 0.392x 0.196	1.796x 1.515x 1.515
WEIGHT (OZ.)	0.5	1.5	1.5	0.6	0.09	4.0

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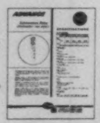

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drives for remotely controlled applications. The control location does not have to accommodate the transformer assembly; it can be installed in any out-of-the-way space and the control station placed wherever desired. For driving the Powerstat a synchronous motor is used. Transformers are designed for use on 120 v, 50/60 cycle, single phase current. The motor requires approximately 0.30 ampere. Planetary gear speed reduction assemblies providing speeds of 5, 15, 30, or 60 seconds for full range travel from zero to maximum output voltage are available with each transformer. Adjustable limit switches at the lower and upper limits of travel are provided. A positioner control system can be incorporated with any motor-driven unit. **Superior Electric Co.**, Bristol, Conn.

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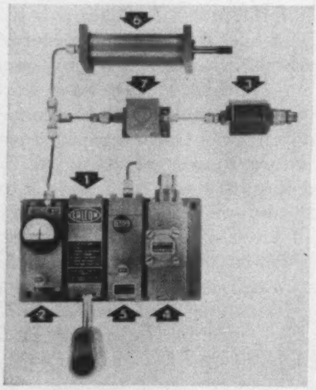


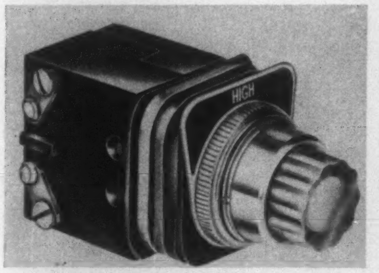
Safety Control System

Pneumatic, self-powered engine safety control system is designed to protect all types of engine installations against dangerous overspeed, temperature, and pressure conditions. Operated through a small captive charge of compressed air, the system requires no batteries or other special electrical supplies. It can operate almost any type of pilot valve, switch, warning, or other device when the captive air charge is dumped to atmosphere by sensing units. The equipment comprising a typical engine installation of the Calcon Model 490 kit (illustrated) is as follows: 1. Hand charging unit. 2. Pressure sensing unit with charge air gage. 3. Coolant temperature sensing unit. 4. Overspeed sensing unit. 5. Lube oil pressure sensing

Circle 719 on Page 19

unit. 6. Actuating unit. 7. Auxiliary temperature indicator. Copper tubing is used to connect all parts of the system. **California Controls Co.,** 1525 Powell St., Oakland 8, Calif.

Circle 450 on Page 19



Lighted Pushbutton

Feature of lighted oil-tight pushbutton is a "turn-to-test" provision. This test feature is especially useful where equipment is located a considerable distance from the control point. Pushbutton provides an instant test to determine if the lamp is burned out. Before pushing the button to start the motor or other equipment, the button is given a half turn. This energizes the lamp circuit without affecting the control circuit and shows whether or not the lamp lights. A similar test can be applied if the pilot should go out after the motor has been started. Six color caps are available. **Industral Control Div., Arrow-Hart & Hegeman Electric Co.,** 103 Hawthorn St., Hartford 6, Conn.

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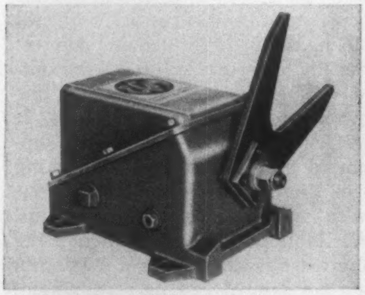
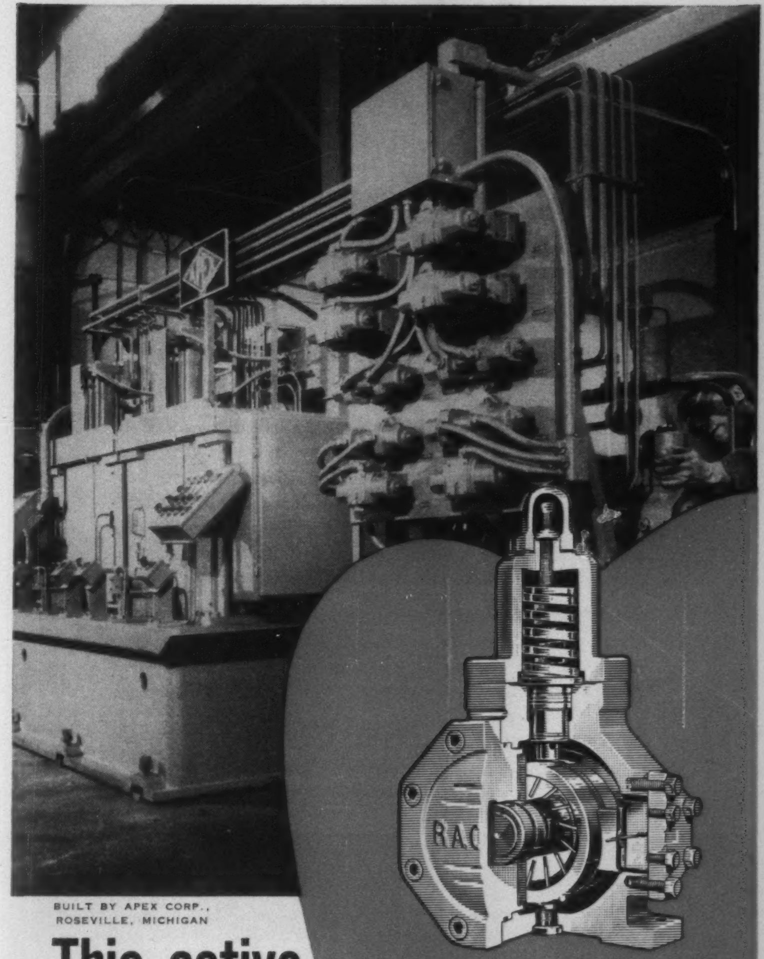


Limit Switch

Developed for high-speed applications such as bridge trolleys and slope hoists, heavy-duty limit switch can be used where travel speed is as



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This active hydraulic heart helps

SEAL POROSITY IN 106 TRANSMISSION CASES EVERY HOUR

A RACINE VARIABLE VOLUME PUMP and 10 RACINE VALVES control *all* mechanical operations in this Apex impregnating machine, which seals leaky transmission cases at a major auto firm's transmission plant in Toledo, Ohio. Apex specified RACINE equipment because its design simplifies machine design problems . . . eliminates the need for extra pumps and valves. RACINE PUMPS are easy-to-control . . . handle pressure compensation *automatically* for varying gpm requirements. Apex has *preferred* RACINE for over 10 years!

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Step-up Production Line EFFICIENCY

Systems are available with speed reducing or increasing gears—with 12- or 24-hour disc charts or with 31-day strip-type charts.

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Use these precision recording devices anywhere that the control of speed, time and measurement is essential to the quality of your products. They tell you how fast and long a machine is used . . . let you measure output versus time . . . fit in perfectly with quality control and time study programs . . . graphically record operation of one machine or entire automated line to help you determine production peaks and valleys, and non-productive time.

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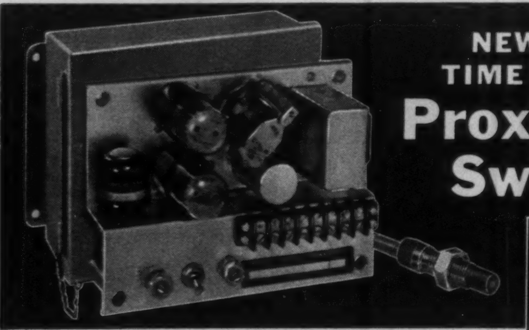
Circle 721 on Page 19



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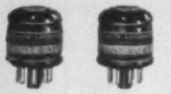
Proximity Switch

WITH PLUG-IN MODULES

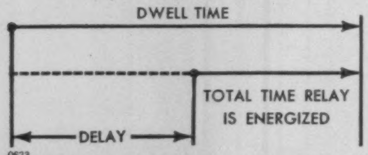
Choice of
2 Time Delay Modules



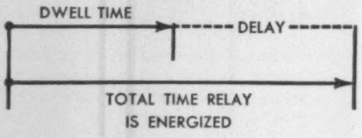
4906-JIC Control Amplifier with 4913-BL Sensing Head

Actuated by NON-MAGNETIC and MAGNETIC metals to solve varied control problems
Built-in time delays eliminate costly timing relays . . . give maximum flexibility at minimum cost.

Delayed relay closure (make)



Delayed relay opening (break)



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Canada: Atlas Instrument, Ltd., Toronto
Proximity Switches • Magnetic Pickups • Tachometers • DC Power Supplies

Circle 722 on Page 19

high as 1200 feet per minute. It can be used for both indoor and outdoor applications. Model TH features a forked operating lever made of a special high impact resisting plastic. This material does not damage the operating bar. Its resilience reduces shock to the interior parts of the switch. **EC&M Div., Square D Co., 4500 Lee Rd., Cleveland 28, Ohio.**

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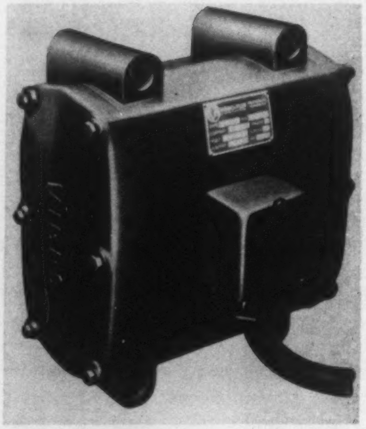

Shuttle Valve

Unit is most commonly used to connect two controlling devices to a single operation. Either of the two controlling devices may control the operation. When one controlling device is actuated the inoperative controlling device is sealed from the line. The valve selects and directs the flow of air from one or the other of the two controlling devices to a common outlet. Only 1 psi pressure differential will seal off the low pressure line and connect the higher pressure line to the outlet. The valve contains only one moving part and has no springs. It weighs six ounces and can be supported by piping alone. Mounting feet are included for installations with vibration or long pipe runs. Available with 1/8 or 1/4-inch ports, the valve is suitable for a maximum air pressure of 200 psi. Maximum operating temperature is −40 to 160 F. Intermittent operating temperature of 200 F is permissible. **Industrial Products Div., Westinghouse Air Brake Co.,** Wilmerding, Pa.

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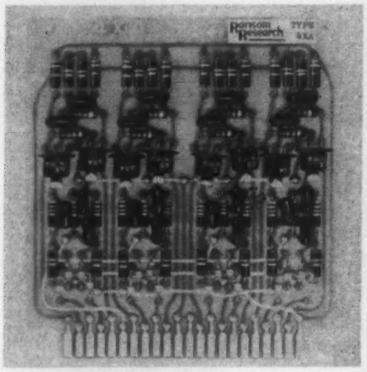

Computer Element

Unit is designed for use as an output storage for holding information in parallel, and as a buffer storage for holding information for parallel or serial shift from one part of a system to another. It consists of four independent flip-flops, each of which has a set 0 and set 1 input. A set gate enables all diode gate inputs as well as a reset line to reset all flip-flops to the 0 condition. Model 4XA storage unit is assembled on a standard $4\frac{1}{2}$ by 5 in. printed circuit card which is provided with a 22-pin PC connector. **Ransom Research,** 323 W. 7th St., San Pedro, Calif.

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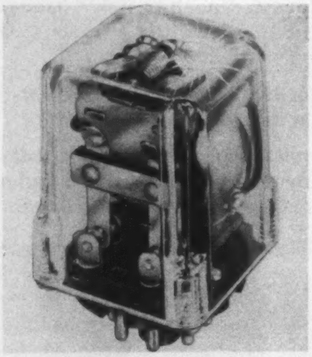
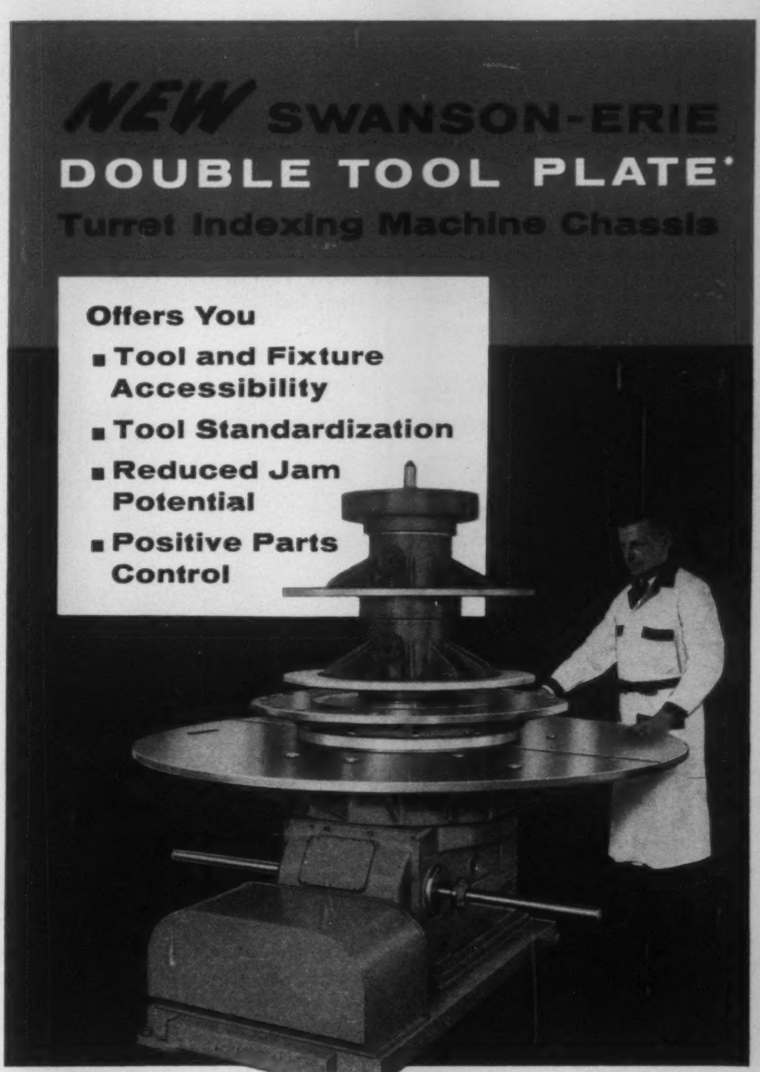


General Purpose Relay

Relay assembly includes built-in neon lamp for use as an aid to trouble shooting power circuits. The lamp is connected in series with a resistor and both components are connected in a circuit parallel to the relay coil to provide a positive means of determining current availability. A transparent cellulose acetate dust cover provides operat-



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Turret Indexing Machine Chassis

Offers You
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- Reduced Jam Potential
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*Patent Pending

■ This new double tool plate indexing machine chassis represents a fresh approach to automatic assembly and processing. Tooling is center mounted on the lower tool plate . . . actuation is provided by the upper tool plate. A cam shaft extension is also available for supplementary tool actuation.

The new design represents an important advance in the SWANSON INTEGRATED CONCEPT that incorporates all necessary facilities for *work transfer, tool mounting* and *tool actuation* in a standard chassis that is built to give you . . .

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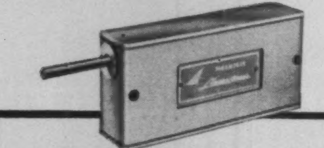
Designers and Builders of Automatic Assembly and Processing Machines.

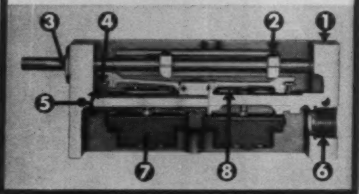
Circle 723 on Page 19

If you design or build automatic machinery . . .



PARAMOUNT LINEAR CONTROL

can save you much time and money



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Standard, heavy-duty unit with two switch elements for "limiting" applications.

Here's the "inside" story

Paramount's new LINEAR CONTROLS are now available in a variety of sizes for limiting, sequencing, monitoring, etc., applications. All heavy duty types built to conform with JIC Electrical Standards.

Paramount's LINEAR CONTROL is self-contained. Therefore, it reduces engineering, inventory, assembly, and wiring to absolute minimum.

1. **Gasketed Cover** completely encloses unit.
2. **Adjustable Cams** clamp to actuator tube.
3. **Self-Lubricating Bearing** and teflon seal.
4. **Reset Stop Screw** limits switch spring action for longest life.
5. **Two Compartment Construction** separates mechanical and electrical.
6. **Conduit Opening**, only one needed.
7. **Heavy-Duty** switch element.
8. **Diaphragm** and retainer around actuating pin oil proofs electrical compartment and aids resetting.

Save time and money designing and building automatic machinery with

PARAMOUNT LINEAR CONTROL

Paramount Textile Machinery Company
131 S. Wabash, Chicago 3, Illinois
Phone: FInancial 6-0125

4-810

Circle 724 on Page 19

ing visibility for lamp and contacts. Model KRP-N can be furnished in production quantities for 6 to 110 v dc and 6 to 230 v ac operation. Silver cadmium contacts rated at 10 amperes are standard for both ac and dc models. Silver contacts are rated at 5 amperes. Contact arrangements are available up to 3PDT. **Potter & Brumfield**, Technical Information Section, Princeton, Ind.

Circle 455 on Page 19

Body Valve

Square body valve has been designed for use as controls on fine quality machine tools, and in other applications where compact, heavy duty, precision made control valves of deluxe appearance are required. Valve bodies, levers, and bases are either machined from bar stock or are castings. Bodies are of a natural finish aluminum. All valves are 1/4-inch size, and most are available in choice of two-way or three-way, normally open or closed. Feature is the choice of two different bases, which permit valves to be mounted either vertically or horizontally, on either a vertical or horizontal surface. Valves are designed principally for air, at pressures up to 125 psi. They may be adapted for valving fluids and other gases, as well as vacuum. Air capacity is 80.04 cfm at 100 psi. Valve is available in seven models which include a ball bearing cam valve; lever and roller type cam valve; and others operated by a pushbutton, a large palm button, large palm button with *Hold*, a vertical lever, and a telegraph key lever. Cam-operated valves may be op-

STROMBERG-CARLSON TELEPHONE HANDSETS

MODELS FOR MANY INDUSTRIAL APPLICATIONS

No. 26: short, lightweight, sturdy. Comes with capsule-type receiver and transmitter.

No. 27: high-gain version of No. 26 handset.

No. 28: "push-to-talk" handset. Rocker bar switch; various spring combinations.

No. 29: high-gain version of No. 28 handset.

Typical applications: mobile radio • intercom systems • carrier and microwave • aircraft and railroad.

Modern handset cradle for mobile or panel use fits any Stromberg-Carlson handset.

Write to Telecommunication Industrial Sales, 111 Carlson Road, Rochester 3, New York. Or in Atlanta call TRinity 5-7467; Chicago: STate 2-4235; Kansas City: HArrison 1-6618; Rochester: HUbbard 2-2200; San Francisco: OXford 7-3630.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

Circle 725 on Page 19

erated at speeds in excess of 30,000 cycles per hour. **Humphrey Products Div., General Gas Light Co.,** Kalamazoo, Mich.

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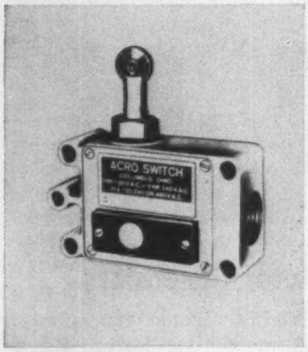

Enclosed Switch

Metal-clad switch is approved for 21 amperes at 120, 240, and 480 vac, as well as 1 hp-115 vac, and 2 hp-240 vac. Feature of the unit is visual indicator, designated Acro-Lite, that gives visual evidence of performance of the switch. Light can be mounted on switch housing or remotely. Choice of five different actuators is possible, and mounting is optional through any of five mounting holes provided. Internal switch has screw terminal contact arrangement. Single pole double throw contact arrangements are provided. **Acro Div., Robertshaw-Fulton Controls Co.,** Columbus 16, Ohio.

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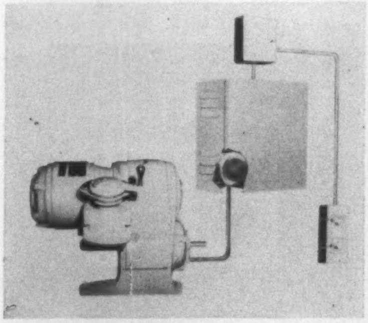

Acceleration Control

Controlled acceleration accessory unit for 1 to 75 hp Varidrive variable speed motor provides a soft, smooth start to minimize any sudden

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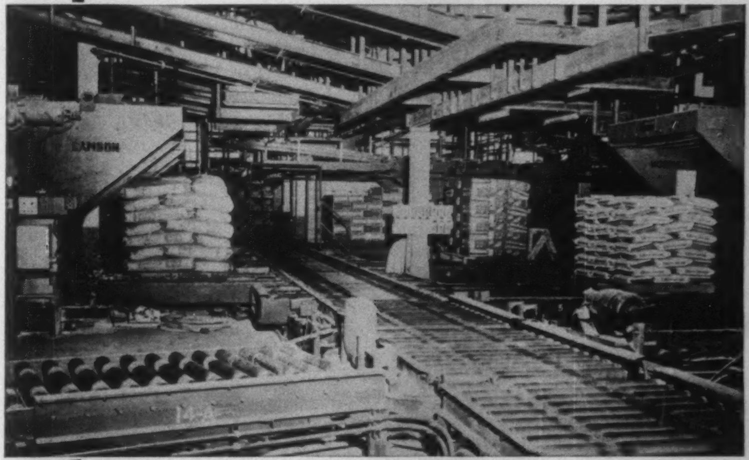
WITH
LAMSON ENGINEERED
CONVEYOR SYSTEMS



Automatic Palletization — the hub of a LAMSON engineered conveyor system linking production lines to warehouse.

You cut production time and the unnecessary handling of materials to the bone with the help of LAMSON engineers. They are specialists in developing materials handling systems that truly increase the capacity of your present buildings and dramatically increase the productivity of your present equipment.

There are more LAMSON custom engineered conveyor systems in successful operation today than any other kind. They are being serviced throughout their life by the same LAMSON field offices that initially analyzed the problem, proposed the solution and supervised the installation.

As a result of this complete, professional service you will find many of the finest names in industry among LAMSON installations. During the past 75 years LAMSON has been active in almost every field, yours included, and perhaps even in divisions of your own firm. LAMSON can cut costs; speed production; increase your profits.

If you have a materials handling problem, write LAMSON today for our conveyor catalog and the name of your nearest LAMSON Field Engineer. Or, simply clip this advertisement to your letterhead and mail to:

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1008 Lamson Street, Syracuse 1, New York

PLANTS IN SYRACUSE AND SAN FRANCISCO • OFFICES IN ALL PRINCIPAL CITIES

Manufacturers of Airtube® (Pneumatic Tube Systems) • Integrated Conveying Systems • Pallet Loaders • Selective Vertical Conveyors • Bookveyors® Clinical • Trayveyors® • Food Service Systems • Blowers and Exhausters • Exidust® Central Vacuum Cleaning Systems • Dryset® Air Vacuum Systems

Circle 726 on Page 19

Power-Flex®

POWER AND FREE OVERHEAD CONVEYOR SYSTEM*

WITH TELEMATIC AUTOMATIC DISPATCH CONTROL

• Simply set dials and Telematic guides carrier to any station in system

POWER RAIL
FREE RAIL

Employs exclusive unitized "over and under" power and free rail which permits simple switching to right or left as desired.

Power-Flex is designed for automated materials forwarding applications in industrial plants, distribution centers, service buildings and department stores. The most economical system available for loads up to 600 lbs. per carrier. Savings in actual installations range from 25% to 60%.

*Systems in service for your inspection.

Engineered to your very specific requirements.

SEND FOR BROCHURE

Inquiries from your engineers or consultants welcomed.

CM® CONVEYORS

COLUMBUS McKINNON CORPORATION
Conveyor Division
TONAWANDA, N. Y.

Circle 727 on Page 19

starts that could damage the machine being driven or the product (such as paper, plastic, or textile materials). It also protects equipment such as extruders where high starting torque may be detrimental to the extruding machine or the motor. To accomplish low initial torque, a reduced torque control unit is used. To suit varying load conditions and machine applications, starting torque is infinitely adjustable up to the normal rated torque of the motor. After setting the control unit for the desired starting torque, a compensator unit maintains this same approximate torque from starting to full operating speed. The unit is designed to operate on standard 220/440 v, 60 cycle power supply. **U. S. Electrical Motors Inc.**, Box 2058 Terminal Annex, Los Angeles 54, Calif.

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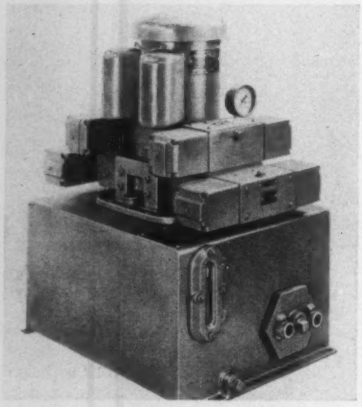

Hydraulic Power Unit

Valves are included in this hydraulic power unit package. Mounted on the 10-gallon reservoir are the electric motor (1, 1½, or 2 hp) and from one to four solenoid controlled 4-way directional control valves, with no external piping. The Gerotor pump within the reservoir is available in 1, 1½, and 3 gpm capacities. The valves (with tandem center spools) are mounted in series to provide automatic unloading. A built-in relief valve protects the system. An optional water/oil heat exchanger can be supplied, built into the reservoir. **Double A Products Co., Subsidiary, Brown and Sharpe Mfg. Co.**, Manchester, Mich.

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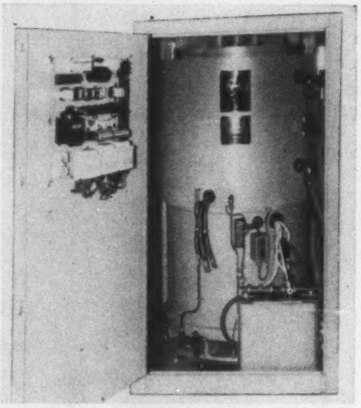

Motor Generators

Vertical motor generators from 7½ to 350 kw feature forced oil lubrication of the upper and lower bearings to give up to twice the normal expected bearing life, and single oversized area water-to-air heat exchanger. Heavy duty welded steel frame is precision machined to maintain concentricity of air gap and proper alignment for the dynamically balanced rotating shaft assembly. Special rotor locking device for shipment places entire weight of rotor on generator frame and removes thrust load from bearings. Generator includes a full complement of protective devices including: Top bearing temperature, motor air temperature, waterstat, generator air temperature, surge protector, ground protector, and bottom bearing temperature. **Ajax Magnethermic Corp.**, 3990 Simon Rd., Youngstown 12, Ohio.

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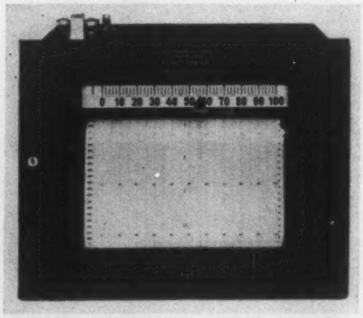

Recording Refractometer

Measurement of extremely small differences in the index of refraction of liquids has been made practicable for process monitoring, quality control, pilot plant studies, etc. by this unit. Typical applications include monitoring chromatographic columns, polymerization control, sugar concentration control, brine concentration control, separation or blending, and purity control. The recording differential refractometer measures index of refraction changes as small as 0.0000007 index of refraction units. The analyzer section is mounted within a standard strip chart recorder, thereby combining an analyzer and recorder in one unit. Full scale ranges as narrow as 0.0003 and as broad as 0.16 index of refraction units are possible. The instrument uses the null balance principle and has zero drift of less than 0.000003 refractive index units per 24 hours. Batch or continuously flowing samples may be analyzed with the instrument insensitive to changes in both ambient temperature and sample temperature. **Waters Associates,** 45 Franklin St., Framingham, Mass.

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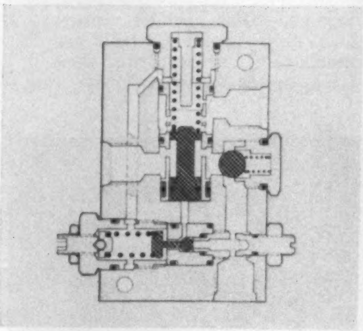
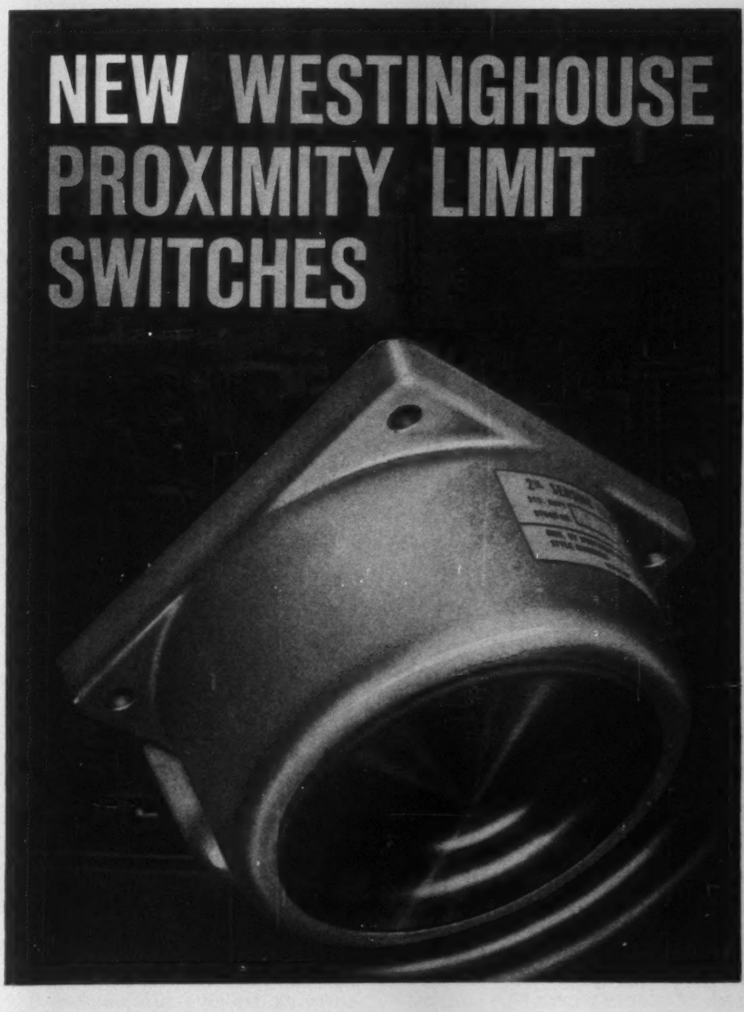


Unloading Valve

Unit is capable of automatically diverting full pump flow to a reservoir when system pressure reaches a preset point. Used in accumulator and hi-lo circuits or for venting large relief valves, this valve offers two features: A 5 to 20 per cent adjustable differential between load and unload pressures for better system efficiency, and a sliding spool that will not stop half way, assuring complete loading and unloading. It has an 800 to 3000 psi unload pressure range and a maximum pilot pressure up to 5000 psi. **Fluid Controls Inc.,** Box 186, Mentor, Ohio.

Circle 462 on Page 19



NEW WESTINGHOUSE PROXIMITY LIMIT SWITCHES

...OUTLAST MACHINES THEY CONTROL

Why? They won't wear out. No tubes . . . no moving parts . . . no contacts to spark, pit or wear. They're corrosion resistant . . . sneer at dust, dirt or oil mist . . . could operate under water. They've passed military shock and vibration tests . . . fit most applications. Two sizes of sensing heads available for tripping distances within ½ inch or within 2 inches.

Cost? Westinghouse proximity limit switches cost a little more—but pay for themselves over and over again because they banish expensive machine down time for switch service and replacement.

CALL TODAY for the facts on the new Westinghouse proximity limit switches. Your nearest Westinghouse sales engineer will show you how they can save you time and money. Or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

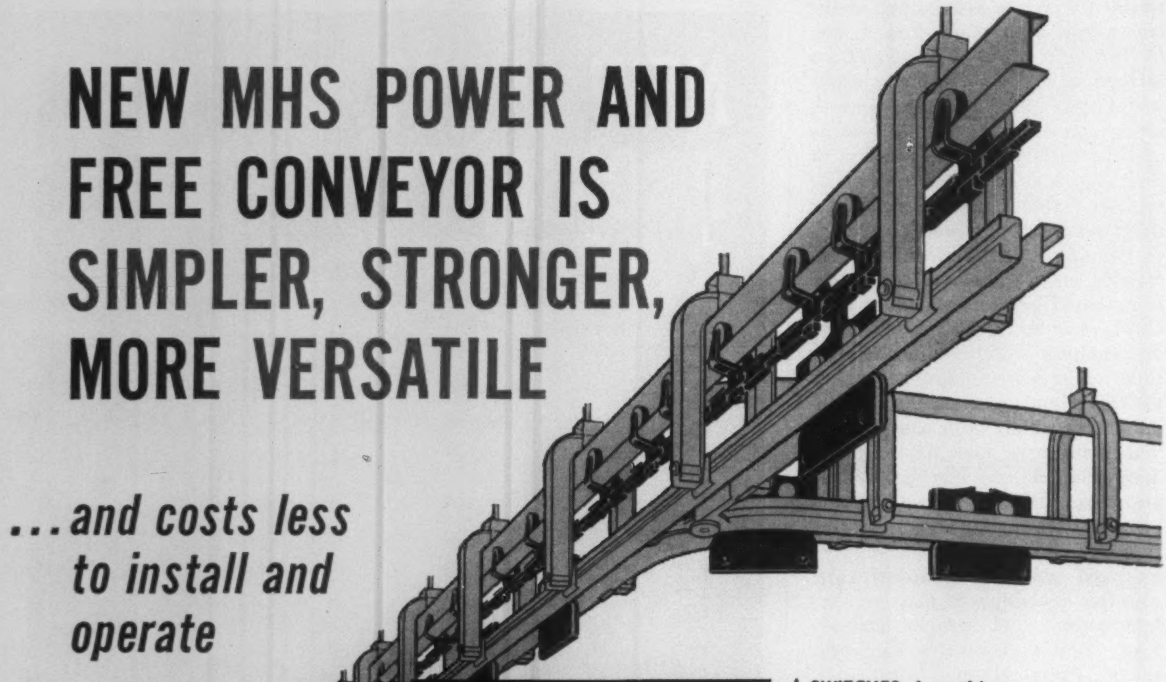
J-25002

YOU CAN BE SURE...IF IT'S Westinghouse

Circle 728 on Page 19

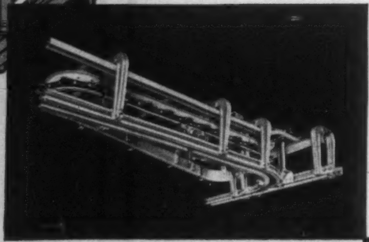
NEW MHS POWER AND FREE CONVEYOR IS SIMPLER, STRONGER, MORE VERSATILE

. . . and costs less to install and operate



The new MHS Power and Free is redesigned throughout. Its low cost, simplified construction and more efficient operation make it economically practical in hundreds of plants where this conveyor type formerly was impractical.

New MHS Power and Free Conveyor is lower in first cost, lower in erection costs, and lower in maintenance costs, too.

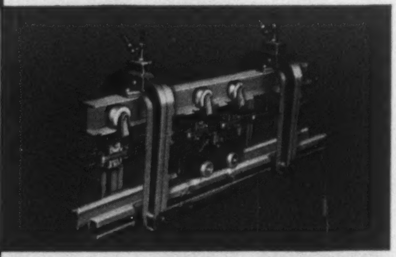


SWITCHES slave driven

Switches, shipped as units, are slave driven and cannot get out of synchronization. For reduced maintenance, switches, feeders, safety devices, interlocks and similar controls are mechanical, rather than electrical or air operated.

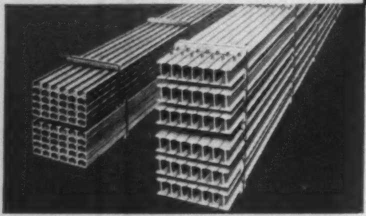
LIGHTWEIGHT strength

Weight is at a minimum, without sacrifice of strength. Load carrying trolleys run on two roll-formed C-sections, back to back. Yokes are formed steel, and are bolted to I-beam by means of pre-positioned studs. Longer unsupported spans are possible.



UNITIZED for simple assembly

New MHS Power and Free is almost a shelf item! Here are standard shipping bundles of I-beam and free track sections—enough for more than 600 feet of Power and Free Lines. Bolted splice plates replace much field welding, make erection easy. Parts are standardized and interchangeable.



LET NEW MHS POWER AND FREE CONVEYORS IMPROVE YOUR OPERATION, REDUCE YOUR COSTS!

Send for Bulletin PF-3 *today*

MECHANICAL HANDLING SYSTEMS INC.
Manufacturing Engineers
4632 NANCY AVENUE, DETROIT 12, MICHIGAN
Branch Offices and Plants in Principal Cities

Circle 729 on Page 19

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 19.

Potentiometers and Generators

Vernistat Div., Perkin-Elmer Corp., Norwalk, Conn.—14 page booklet—Design features, applications, and operation of both ac potentiometers and adjustable function generators are covered in this catalog. Nonlinear characteristics of the devices are discussed. Mechanical operation is explained and illustrated by means of diagrams. Illustrations include a list of types for specific design objectives.

Circle 463 on Page 19

Electrically Operated Valves

Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio—20 page booklet—Bulletin 91024 contains data on 2, 3, and 4-way electrically operated valves. These valves comprise Series 23000 and 24000, 33800, and 43000. They are used for air, oil, water, or vacuum applications. Descriptions, specifications, features, flow charts, and optional features of the various types of available valves are discussed.

Circle 464 on Page 19

Axial Piston Pumps

Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus, Ohio—8 page bulletin—Data are given in Bulletin 203 on line of axial piston pumps used at pressures up to 5000 psi. Series 30, 40, and 50 pumps in constant and variable volume models are discussed. Performance and torque curves are illustrated. A rating chart for both pumps and fluid motors, ranging in maximum pressures from 3500 psi to 5000 psi, is included. Accessory valves and controls used in 5000 psi systems are reviewed.

Circle 465 on Page 19

Analog Computer Applications

Computer Systems Inc., Culver Rd., Monmouth Junction, N. J.—16 page booklet—Mathematical applications of a dynamic storage analog computer are the subjects of this booklet. Discussed are sequential calculations through time sharing of computer elements; use of memory to obtain definite integrals for automated, self-solution of optimization problems; solution of multiple integration problems by a combination of repetitive and real-time operations together with continuous or point memories; and the solution of partial differential equations. Another application covered in this bulletin is the use of continuous memory for solution of complex transient operations and difference-differential problems.

Circle 466 on Page 19

Variable Pitch Sheaves

Browning Manufacturing Co., Maysville, Ky.—24 page catalog—Line of multiple-groove, variable pitch sheaves is described in Catalog MVP-101-A. Two types of sheaves, fixed bore and bushed type, are covered. Details are given on two groove sizes, A-B and C. Selection tables are included for these sizes for sheaves having 2 to 6 grooves.

Circle 467 on Page 19

Meter-Relays

Assembly Products Inc., Chesterland, Ohio—12 page booklet—Bulletin describes a line of expanded scale meter-relays capable of monitoring and controlling any variable that is measured electrically. The units feature contact life of 10 to 20 million operations when used in recommended circuits, require low current and voltage inputs, and are available with high or low limit single adjustable contacts, double adjustable contacts, or fixed contacts. Schematic diagrams illustrate typical circuit arrangements, and dimensional drawings give installation data.

Circle 468 on Page 19

Strapping Tools

Signode Steel Strapping Co., 2600 N. Western Ave., Chicago 47, Ill.—4 page pamphlet—Bulletin SPD 238 gives information on twelve models of combination strapping tools. Specification chart lists typical applications for each of four electric-powered tools and eight air-powered models, the maximum strap tension and weight for each, and strap width and seal size to be used in the various tools. Details on appropriate tool mounts, balancers, balance arms, and suspension brackets are also given.

Circle 469 on Page 19

Infra-Red Components

John J. Fannon Products Co., 3000 E. Woodbridge, Detroit 7, Mich.—8 page bulletin—Data are given in Bulletin 62460 on components for electric quarz infra-red heat applications. Typical examples of infra-red wattage requirements for various uses are covered. Information is provided on how to set up an infra-red system in a plant. Requirements for various elements for 2, 4, and 6 panels are provided by means of a table. Schematic diagrams illustrate construction features of front wire connected heater panel assembly (Series F) and back wire connected (Series B).

Circle 470 on Page 19

Telemetering Equipment

ASCOP Div., Electro-Mechanical Research Inc., P. O. Box 3041, Sarasota, Fla. —8 page bulletin—Applications, features, and specifications on industrial telemetering equipment are given in this bulletin. Schematic diagrams are used to illustrate operation of the transmitter and receiver. Details are related on a single system (2 to 30 points) and a multiple system for 2 to 2100 data points.

Circle 471 on Page 19

Flaw Detector

Branson Instruments Inc., 40 Brown House Rd., Stamford, Conn.—8 page Bulletin—Subject of Bulletin T200 is an ultrasonic flaw detector designated as Model 5. Advantages of this pulse-echo instrument are described. By sending short pulses of acoustic energy at ultrasonic frequencies into the object under test, the flaw detector can examine the interior of metals, glass, plastics, and body tissue, from one side only and without physical damage. Indications of defects by variations in the object's characteristic trace on a cathode ray tube, and approximate depth, determined by a pyramid marker superimposed on the base line are discussed. In addition to describing techniques, such as use of straight beams, angle beams, and surface waves, the bulletin discusses application of contact, immersion, and water column testing methods. All recognized pulse inspection techniques are applicable to Model 5. Three accessory plug-in flaw alarms, available for automatic monitoring of inspection, are noted.

Circle 472 on Page 19

Process Equipment

Sprout, Waldron & Co. Inc., 130 Logan St., Muncy, Pa.—8 page bulletin—Line of process equipment and systems is outlined in Bulletin 200-B. Information on size reduction equipment, size classification equipment, materials handling air systems, bulk trucks, pelleting equipment, and pulp and paper mill equipment is supplied. Illustrations accompany each of the equipment descriptions.

Circle 473 on Page 19

Control Valves

Ross Operating Valve Co., 120 E. Goldengate Ave., Detroit 3, Mich.—18 page booklet—Applications, features, and specifications on a line of control valves are given in this catalog. Types of valves covered include solenoid, air, hand, foot, and cam operated. Auxiliary valves such as speed control, quick exhaust, and non-tie-down are also covered. All descriptions are accompanied by illustrative diagrams and photographs.

Circle 474 on Page 19

Bar-Graph Oscilloscopes

Industrial Products Div., International Telephone and Telegraph Corp., 15191 Bledsoe St., San Fernando, Calif.—2 page pamphlet — Bulletin describes bar-graph oscilloscopes, Models DC-40BG and AC-40BG. Features noted include "quick lock" display of up to 40 variables for continuous monitoring, measurement, and observation of drift and changes; floating inputs with mode rejection; and ultra-stable circuits. Typical application problems being studied and analyzed by means of these instruments are listed.

Circle 475 on Page 19

Measurement & Control Systems

Sales Dept., Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus 2, Ohio—12 page booklet—Data are contained in Booklet PL-560 on methods of measuring and automatically controlling the three significant thickness variables of extruded plastic materials. These are: Long-term machine direction variations, short-term machine direction variations, and profile variations. Measurement and control systems designed to reduce these variations to a minimum are described. Covered in the bulletin are systems used to control extruded blown film, flat die extruded film and sheet, and extruded coatings.

Circle 476 on Page 19

Ballizing Process

Industrial Tectonics Inc., 3686 Jackson Rd., Ann Arbor, Mich.—12 page booklet—Bulletin B-46 covers a ballizing process for high-speed hole sizing and finishing. Details are given on how the process works and conditions best suited to its operation. Case-history data on ballized parts are given as well as information on how to determine production details for any application. Installation setups covered include semi-automatic and automatic.

Circle 477 on Page 19

Expanding Arbors

LaSalle Machine Tool Inc., 3840 E. Outer Drive, Detroit 34, Mich.—2 page pamphlet—Expanding arbors that will accurately position any type of part (or tool) for machining, grinding, and inspection operations is subject of Bulletin 120. Types of arbors such as broach fixture, gage, and grinding are illustrated. Expanding sleeves with staggered and within-line grooves are also shown as well as a locator post. Design features of the devices are listed.

Circle 478 on Page 19

Film Recorders and Reproducers

Recording Equipment Dept., Westrex Corp., 6601 Romaine St., Hollywood 38, Calif.—4 page pamphlet — Precision recorders, reproducers, and recorder/reproducers for any type of film currently used in the motion picture and broadcast industries are the subject of this booklet. Features of Series RA 1500 such as 3000 ft reel capacity; fast rewind; and choice of 8 interlock, synchronous or composite motors, 50/60 cycles, are listed. All models described are accompanied by appropriate illustrations.

Circle 479 on Page 19

Combustion Safeguards

Selas Corp. of America, Dresher, Pa.—12 page booklet—Data are given in Bulletin CS-2 on a line of automatic safeguards (for detecting, localizing, and extinguishing flashback in a mixture supply line close to burner or group burner manifold) and a safety blowout (for preventing flashback in main supply piping from damaging premixing equipment and for relieving excessive flashback pressure). Both assembled and exposed views of the firechecks are shown. A safety blowout is illustrated and described. Drawings, dimension data, piping diagrams, and principles of operation are included, along with listings of auxiliary equipment and combustion accessories.

Circle 480 on Page 19

Photoelectric Cells

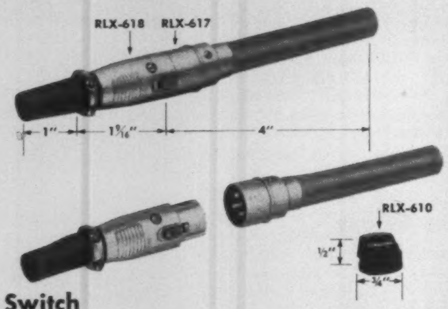
Photomation Inc., 96 S. Washington Ave., Bergenfield, N. J.—6 page pamphlet —Data on photoelectric cell devices are discussed in Bulletin 577. Applications and principles are discussed. Direct light and reflected light diagrams are used to indicate various applications. Dimensions are given for light source units, photocell units, relays, and relay-counters.

Circle 481 on Page 19

Engine Controls

Synchro-Start Products Inc., 8151 N. Ridgeway Ave., Skokie, Ill.—12 page booklet—Bulletin 600 describes a line of engine controls which are designed to automatically start and stop gas, gasoline,

POST
ELECTRONIC
PRODUCTS



NEW!

MH-2-P Magnetic Switch

A new and improved sensing device . . . neatly contained in an epoxy resin shell. The MH-2-P is ideal for industrial applications and is easier to mount in areas of limited access. A quick disconnect Cannon connector eliminates elbow type construction.

The new epoxy resin housing results in less magnetic flux and increased sensitivity. As a consequence, smaller magnets can be used and manufacturer reports a minimum magnetic field transient time of only 8 milliseconds is needed to activate the switch. Operating life is in excess of one billion operations.

Write For Bulletin MH-2-P

Decitron

POST ELECTRONIC PRODUCTS
Division of Reid Brothers Company, Inc.
12 LOTHROP ST. / BEVERLY, MASS.

Circle 730 on Page 19

or diesel engines from a remote location. Series 46 and 56 are included in this line. Control recommendations for the Series are given. Models with one, two, three, and four signal lights are covered. A control selection chart is included.

Circle 482 on Page 19

Air Conveying Systems

Dept. K-P2, Flo-Tronics Inc., 1420 Zarthan Ave., Minneapolis 16, Minn.—4 page pamphlet—Air conveying systems for the bulk handling of powdered or granular materials are described in this brochure. Numerous variations possible in the engineering of air conveying systems, including automated and programmed process controls, are covered. Diagrams show typical equipment and systems arrangements.

Circle 483 on Page 19

Machine Tools

Ex-Cell-O Corp., 1200 Oakman Blvd., Detroit 32, Mich.—12 page booklet—Line of numerically controlled machine tools for milling, profiling, and contouring operations are described in Bulletin 5060125. The machines covered all use continuous path control. Photographs are used to illustrate design features of the various machines.

Circle 484 on Page 19

Depalletizer

Alvey Conveyor Mfg. Co., 9301 Olive St. Road, St. Louis 32, Mo.—6 page pamphlet—Bulletin F-225 describes Model 300 automatic depalletizer which is designed to receive a pallet load of cases and to automatically remove the cases from the pallet at a rate of from 40 to 50 cases per minute. Electrical controls permit changing the depalletizing operation from one case size to another by actuating a switch. A schematic diagram illustrates the eight automatic steps involved in the operation. Photographs illustrate features of the unit, and other diagrams show case patterns that can be unloaded and equipment layout dimensions.

Circle 485 on Page 19

Pressure Regulators

OPW-Jordan Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio—8 page bulletin—Sliding gate pressure regulators described in Bulletin J160-1 can be used on steam, water, air, oil, gas, or corrosive chemicals. Details are given on four basic types: Self-operated, pilot-operated, solenoid operated, and back pressure. It is explained how the sliding gate construction gives straight through flow.

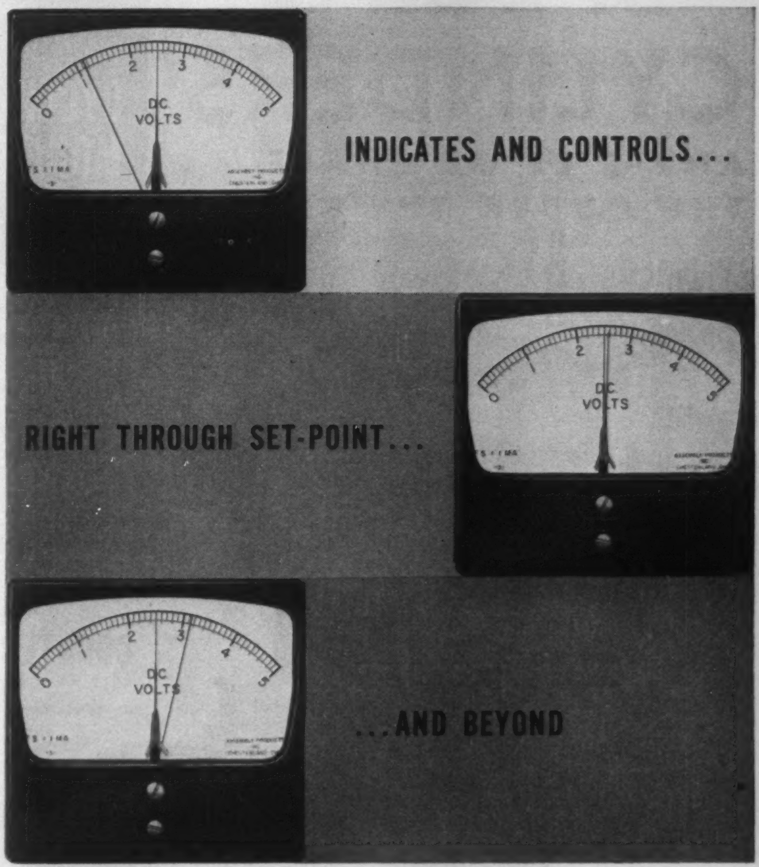
Circle 486 on Page 19

Punched Tape Accounting

Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.—6 page pamphlet—Bulletin 671-147 outlines system of punched tape accounting which produces both a printed and punched tape in one simple adding machine operation. System involves use of a data punch adding machine for preparation of data. Samples of both the printed and punched tapes are provided.

Circle 487 on Page 19

NEW—CONTINUOUS READING METER-RELAY



GIVES CONSTANT CONTROL

UPSCALE OR DOWN

API's new Continuous Reading Meter-Relay (CRMR) can do a diversity of control jobs for you. It will monitor and control just about any variable that can be translated to electrical values. It will handle low-level microamp or millivolt signals without amplification. In many applications, the CRMR's high sensitivity will permit simplification of control circuitry. In any application, it will give accurate (±2% or better), non-cyclic control.

The CRMR is simple. It consists of a D'Arsonval meter with toggle-mounted contacts; a load relay does the control switching. No signal-sampling interrupters are required. Reset is automatic and instantaneous.

Reliability? The CRMR is right now in service on such critical applications as monitoring radiation level.

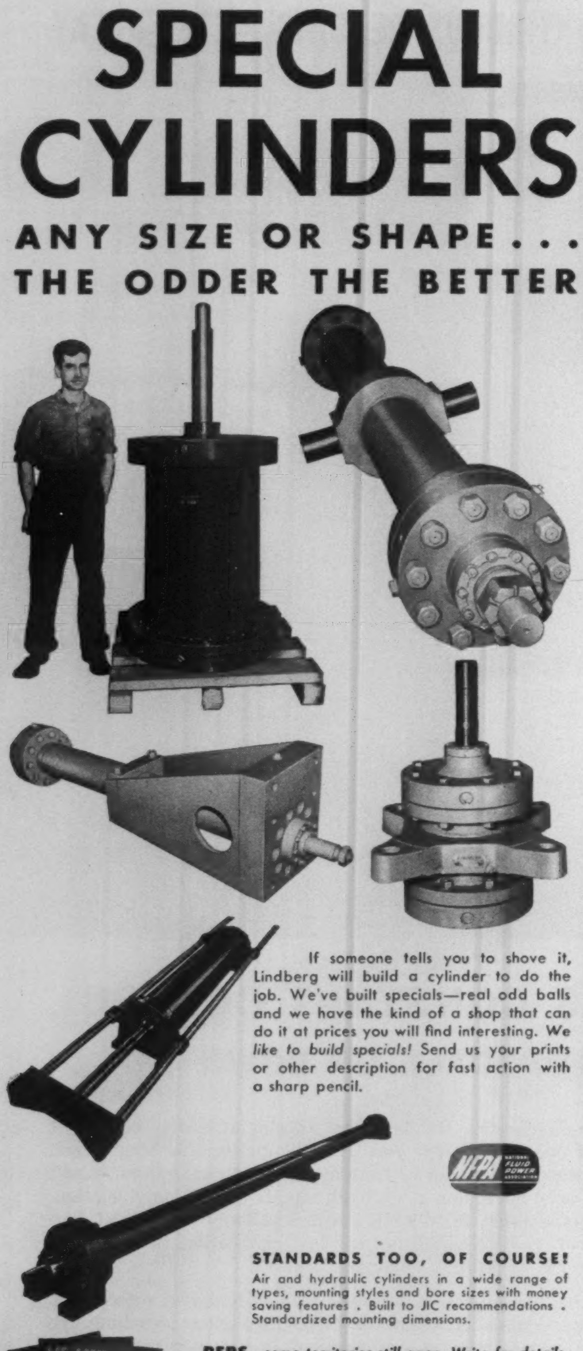
Our Bulletin S-2-1 shows how the CRMR works, and gives full details on available ranges and prices. The latter, not incidentally, are a lot less than you might expect for so versatile an indicating control.

api

ASSEMBLY PRODUCTS, INC.
Chesterland 27, Ohio

S.A. 2203

Circle 731 on Page 19



SPECIAL CYLINDERS

ANY SIZE OR SHAPE . . . THE ODDER THE BETTER

If someone tells you to shove it, Lindberg will build a cylinder to do the job. We've built specials—real odd balls and we have the kind of a shop that can do it at prices you will find interesting. We *like to build specials!* Send us your prints or other description for fast action with a sharp pencil.

STANDARDS TOO, OF COURSE!
Air and hydraulic cylinders in a wide range of types, mounting styles and bore sizes with money saving features . Built to JIC recommendations . Standardized mounting dimensions.

REPS—*some territories still open. Write for details.*

FOR MORE INFORMATION ON STANDARDS, WRITE FOR THESE BULLETINS!

BULLETIN S-101-A—SQUAREHEAD "S" LINE
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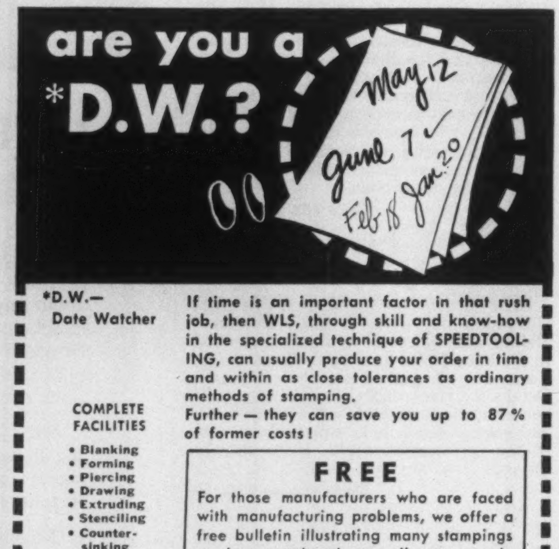

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AUTOMATION abstracts

AUTOMATING ASSEMBLY

By C. H. STANDISH
President
Designers for Industry Inc.
Cleveland, Ohio

AUTOMATING assembly operations offers manufacturers one of their greatest opportunities for labor savings. The importance of assembly has increased in recent years as other major areas in manufacturing have reached a high level of efficiency. After the mechanization of parts manufacture came the mechanization of materials handling. Most modern plants are fairly well advanced along this line, although automatic assembly operations are making new demands on materials handling processes.

There is no end to the technical possibilities for automatic assembly. In the broadest sense, it would be desirable to pour raw material into one side of an automatic factory and get finished products out of the other. In many industries today, this may not be economically feasible, although assembly of certain products approaches this goal. In breadmaking, for example, raw materials are poured into one end of the line, and wrapped, baked loaves of bread emerge from the other.

Special engineering skills and a knowledge of an extremely wide variety of manufacturing methods have been and are being brought to bear on automatic assembly problems. This has resulted in the development of a new technology, growing out of the research efforts applied to specific problems of assembly. Various basic approaches and devices have been developed which can be applied over a broad range of industry.

Unique Requirements

The question may well be asked: What is so different about automating assembly as compared with problems of machine design? A different kind of thinking is required. A creative engineering group is needed, as opposed to the machine shop type of design and build. More time must be spent on the conception of a design, but at the very same time more machine shop type of experimentation is required as a phase of the project.

Automating assembly often requires a team with a diversity of backgrounds: A mechanical engineer, an electrical engineer, perhaps a metallurgist, an industrial engineer, a manufacturing engineer, and several others with related skills who can work closely together on a short-term project. Available know-how must cover as many of the known industrial processes as possible, because the application of processes from other fields may often spell out the solution to the problem at hand.

The engineering team must consider not only the particular problem, but also survey the rest of the anticipated assembly line. They must make sure that the input of their machine is compatible with the output of the preceding machine.

A large part of the conceiving of an idea, or at least the proving out of a concept, requires a laboratory facility where jigs and fixtures can be mocked up. Also, a good supply of instrumentation is required to record experimental test functions.

The Feasibility Study

It is advisable to conduct a feasibility study for each machine preceding actual equipment design. The purpose of a feasibility study is to pinpoint costs, ensure a working design, and point out modifications in product or process that will facilitate automation. It also defines objectives, thereby reducing design risk, and permits disseminating specific information among several contractors, if outside services are to be used, permitting them to prepare firm bids based on the findings of the study.

Before the feasibility study is started, problem areas should be anticipated, and costs estimated for budgetary purposes. Next, manual operations should be observed in the plant. Engineers should act as disinterested observers, discussing details of production techniques with the cognizant engineers and later with people on the assembly floor. Production engineering notes should be taken in minute detail, covering everything from yield per operator to the type of tools they use.

If an existing operation is being studied, responsible people close to the operation will often point out certain practices that "you cannot do" and certain "very gray areas." This is one form of setting limits on the investigation. The engineer doing the study may very well ask why each of these bans has been established so that he will have an answer on record. He should realize, however, that if he attempts to work in these off-limit areas, he will have to prove beyond the shadow of a doubt that his conclusions are valid. He will do best most often either to wait until the persons responsible for the operation conduct the investigation themselves or to drop the idea completely.

The product should be defined as far as possible for the following: 1. Size. 2. Shape. 3. Material. 4. Tolerances. 5. Quality control on parts being fed into the machine. It is most important that the product designers, quality control group, and machine designers fully understand the actual variations on incoming parts which may be expected, instead of accepting blueprint tolerances. The tolerances that can be accepted by automatic assembling equipment may be a great deal smaller than those which can be accepted by the manual or semiautomatic operations.

Once the product has been defined, attention to redesign may make the difference between a successful or unsuccessful automatic equipment development program. Such changes as fewer number of parts to be handled, simpler parts configurations leading to simpler handling, or closer tolerances on parts fed into the machine can drastically cut equipment costs and improve equipment operation. Consideration should be given to anticipated future product design changes and avoidance of obsolescence.

The operations to be performed should then be written down in paragraph form, and a complete procedure diagram should be drawn up. A sequence diagram is the first step. This does not mean that each step will be retained in the final design. It is, however, an orderly definition of all steps to be performed along with pertinent details of the technology involved. In this phase, only those remarks that describe the process should be recorded. For example, if two parts are to be joined and the method of joining has not yet been defined, it should be noted only that "parts are to be joined" and not "parts are to be joined by riveting and then inverted."

Attempting to fill in details may cloud subsequent thinking because upon further study it may be decided not to invert the parts and not to rivet them. The sole purpose of defining and isolating operations at this time is to record known essentials so that they can serve as a basis for more detailed design later. *The automation engineer must keep his thinking as basic as possible for as long as possible.* If he allows himself to become involved with details, he has stopped the "conception" portion of the project and has started to design.

After the sequence diagram has been prepared, those steps should be identified that require advances in the state of the art or which involve extremely close tolerances that would be difficult to achieve by standard methods, operations that involve high speeds, and other potential trouble areas. Time should be allocated to each area of primary emphasis for experimental and logical study.

The feasibility study results in a preliminary machine layout and a comprehensive report of experimental and logical investigation. It differs from a design specification in that it often presents several practical methods for a given operation, thus leaving some room for decision by engineering management. The report also discusses the pros and cons of different processes and techniques, makes recommendations, and gives information leading to the preparation of design specifications.

Basic Building Blocks

Any automatic assembly machine can be broken down into stages. Each stage involves a mechanism, or

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what might be considered a basic building block. Many of these can be purchased as commercially available units; others require special design, according to the product.

Feeders: Feeding can generally be accomplished by using some of the commercially available feeder mechanisms. Usually the problem of selecting the type of feeder device is straightforward. It may be desirable to incorporate storage, parts-selectors, and orienting devices with the feeder unit. These form a complete study in themselves, and it is advisable to bring in the experience of a supplier of such equipment.

Escapements: An escapement, which is basically a metering and orienting device, is needed whenever parts are automatically fed into a machine. Examples are mechanical fingers of various types, pushers, coin-dispenser mechanisms, mechanical clamps, and grip-and-move devices. If a material, such as the ribbon in a ribbon spooling machine, is fed continuously into the machine, the escapement is usually just an opening or a slot, closed periodically by a knife which cuts off a fixed amount of material after it has entered the machine.

Transfer Mechanisms: Moving the part from one station to another can be accomplished by continuous or cyclic mechanisms. Although constantly moving conveyors or fixtures can move parts through processes at very high speeds with great accuracy, individual operations such as positioning and fastening must be custom designed to permit working in conjunction with the moving workpiece. More often cyclic or indexed operations are employed for assembly. The part may be gripped and moved from station to station, or a fixture may be used to hold the part.

The choice of in-line or rotary configuration of the assembly machine must be made during the conception or design stages. Actual space limitations for the machine, number of operations to be performed, and accuracy of location are some of the factors to be considered. Ordinarily, where very accurate indexing is required between stations and there are no serious space problems, the rotary table will serve. The round or turret machine is recommended for most assembly and machining operations where the number of operations and space requirements for assembly tools do not exceed the space available on the outside of the turret.

Controls: The selection of controls is a comprehensive field in itself. Briefly, it may be said that the type of controls used depends largely on machine function and cycling of operations. Mechanical and electrical controls are most frequently employed, often in combination with electronic, pneumatic, or hydraulic systems. Mechanical controls serve for a straightforward approach and permit malfunctions to be readily visible. Motor drives and low-cost interlocks lead to the use of limit switches and electrical controls. Electronic controls serve for more refined applications which may include feedback control, variable programming, data processing, and recording. The use of pneumatic controls permits the installaton of low-cost, fast acting components, and hydraulic systems are primarily suited for heavy-duty installations.

Machine Proper: This element of the equipment performs the actual assembly operations. The design of

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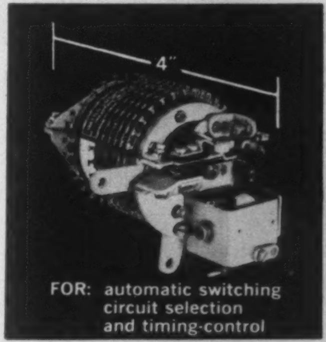
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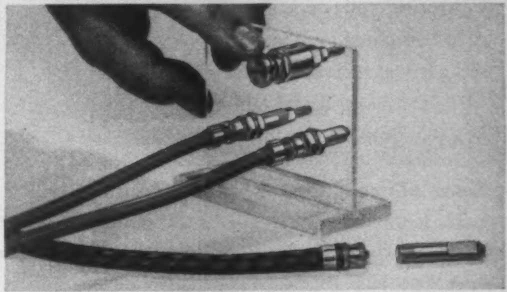

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this part of the equipment must be such that it can perform the assembly operations peculiar to the product.

Auxiliary Operations: The term "auxiliary operations" is used here to mean fabrication, quality control, sensing, and other operations which are used on automatic assembly machines. Often it is of advantage to manufacture a part right at the machine. Where the manufacture of a part as an auxiliary operation simplifies assembly and reduces costs, it should be very definitely considered.

Similarly, quality control operations should be included on the automatic assembly machine wherever possible. One of the biggest items of costs for modern assemblies, particularly in the electronics field, is the testing of complicated assemblies. Very often quality control costs are equal to or greater than costs for assembling the product.

Ejection: The last operation of any assembly machine is ejection of the assembly. This can be anything from random ejection, where parts are dropped out of a machine into a box or onto a conveyor, to an orderly ejection process into a magazine which will be fed into another machine or into a packaging operation. The ejection process can be refined in a number of ways, one of which is to sort finished assemblies by classes. This requires the machine to sense whether it has made an assembly of top quality or medium quality, etc., and to dispense it into its proper bin.

Proceeding from the particulars back to general considerations, perhaps one more point should be emphasized. Manufacturers too often wait to be forced into automatic equipment development programs. Design of automatic assembly machines, refinement of processes, and design of product should proceed together with close co-operation between engineering groups to stay ahead of today's short-lived markets.

From a paper entitled "Automating Assembly," presented at the Fourth Conference on Manufacturing Automation co-sponsored by Purdue University, AUTOMATION, *and Manufacturing Engineering Council, Lafayette, Ind., April,* 1960.

PHOTOELECTRIC CONTROL OF A STICKY LOOP

By C. B. ANDERMAN
Instrument Engineer
Armstrong Cork Co.
Lancaster, Pa.

IN PRODUCING tubular insulating material, difficulty was encountered in maintaining a constant quantity of material in a free dip between the extrusion machine and the take-away conveyor. The extreme plasticity of the material made the free-handling dip essential and also precluded any mechanical device to sense dip level. The take-away conveyor had been furnished with adjustable speed control, but variations in extrusion rate made adjustment of conveyor speed a full-time job for the machine operator.

After experimenting with several tube position sensing devices, the final design incorporated multiple groups of silicon diodes. These were used as light sensing elements, with individual transistorized amplifier circuits, and made it possible to sense vertical displacement of the tube dip over several inches of travel.

The amplifier outputs provided a proportional speed control signal and could be applied directly to the motor control on the conveyor drive unit. Additional circuitry made it possible to determine direction of excursions beyond the sensing range and, hence, to always produce a proper corrective signal without limiting the vertical travel of the tube by mechanical means.

Separate adjustment of amplifier outputs made it possible to produce a nearly smooth proportional band control. Retaining a manual rheostat in the circuit provided manual reset adjustment, as well as immediate switching to manual control if necessary. Resultant equipment effectively controls dip height to plus or minus 1/8 inch.

From a paper entitled "Automatic Solid State Industrial Control Application," presented at the Symposium on Solid State Techniques in Instrumentation sponsored by the Instrument Society of America, Philadelphia, November, 1959.

PROCESSING OF ENGINEERING DATA

By H. T. MARCY
Manager, Technical Development
Data System Div.
International Business Machines Corp.
Poughkeepsie, N. Y.

MANUFACTURERS have learned to use modern computers and data processing equipment in their operations. Only recently, however, has there been any indication that there might be a change from the classic use of the mechanical drawing as the specification upon which all manufacturing operations are based.

Generally speaking, any item which can be described logically by a set of English language statements can be described in the language of digital computers. The same is true for any set of operations—if they can be described logically with a set of rules as a background, then they can be described in the language of the digital computer.

At IBM we are building advanced data processing machines. Such machines are comprised of digital or logical equipment and such associated apparatus as devices for processing magnetic tapes or punched cards. Defining the assembly of the electronic portions of a computer is an especially difficult problem. A typical machine may have one hundred thousand wire connections on the circuit panels. We have in operation at several locations in IBM a data processing system which contains the basic engineering information for the machines, as well as the manufacturing instructions. This system of records mechanization is having a profound influence on the manufacturing organization.

The electronic computer designer, the test man in final assembly, and the serviceman all make use of what are called logical diagrams. These diagrams describe the signal flow through the machine. The com-

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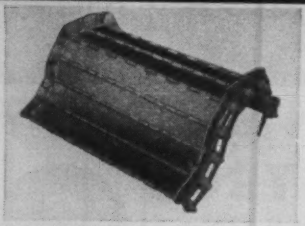

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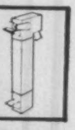
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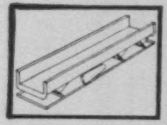
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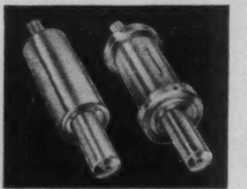
(Left) plain type. (Right) with longitudinal positioning nuts. Both are shown with BLANK SPINDLE END for machining by user.

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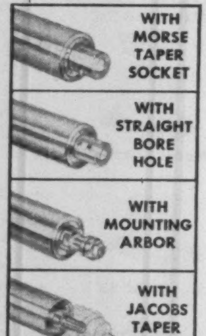

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puter design engineer makes a logic sketch of the machine functions he wishes to perform, including the primary data for physical location of the necessary circuits and their standards identity.

Then, this raw logic is transcribed into punched cards by experienced keypunch operators, who have learned to read from the boxes the designations that identify the standard cards the designer has called for. These data are fed to an IBM 704 or 705, and internal processing produces a master tape record describing the machine. Much supplementary information is automatically handled and added to the basic design sketch. The whole process has been formalized, and the finished drawings are prepared, not by draftsmen, but by machine. The automated logic diagram is the first result.

A supplementary function of checking is performed at the time the logic pages are processed. The logic checking program reviews a complete section of a machine for adherence to design standard rules, for inconsistencies, and for redundancies in page-to-page circuit notations. This, a most valuable part of the operation, develops an errata listing to be returned to the engineer for corrective action. Thus the master tape can be corrected before the manufacturing action documents are derived. Experience has shown that it may take an average of four passes of the logic before it is clear of inconsistencies and record errors.

While the logic diagrams are useful in designing, manufacturing, final testing, and servicing of machines, they are not of themselves the primary documents needed to manufacture the machine. Neither has there been a cost saving in the process of eliminating the draftsman, for he has been replaced by data transcribers and machine operators; albeit, the accuracy of the draftsman is poor compared to his replacement.

The real gain is derived from processing the master tape to obtain a consistent set of documents of direct importance to manufacturing. First, a bill of material is automatically developed. It contains some significant information, such as the total amount of each kind of wire and the length of wire required in each separate piece.

Additional documents are then prepared by the machine to instruct manufacturing in wiring the machine. Wire lists are produced, and ordered in the proper sequence for assembly so as to have the correct routing and terminal stacking. These data are also made available on punched cards for use in automatic wiring machines. Incidentally, there is computation performed to route the wires for minimum cross-talk or capacitive pick-up, which is a potential source of trouble in electronic circuits of digital computers using pulse data.

Several service functions are derived from the manufacturing data; two important ones are an assembly time estimate, and a complete cost estimate for manufacturing.

When changes are made in the machine, which is a frequent occurrence in the early stages of production, they are processed through the same records system. For a change, however, there is a double output; an add-delete listing for correction of machines on the line and in the field, and a revised set of manufacturing documents for subsequent machines. This technique for handling changes has allowed the manufac-

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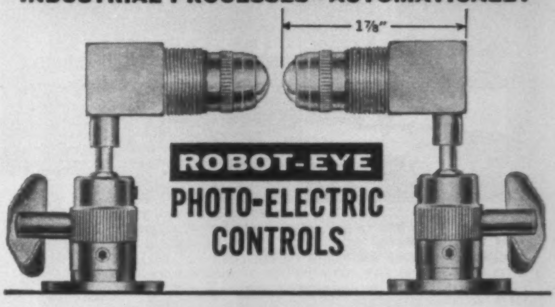

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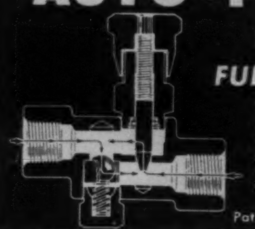

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Model F Standard Flow Control Valve or Model N Needle Valve

Model KF Knob and Dial Flow Control Valve or Model KN Needle Valve.

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CLOSE CONNECTION

Controlling Double Acting Cylinder

TWO DIRECTION CONTROL

CLOSE CONNECTION

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Circle 746 on Page 19

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- Compact
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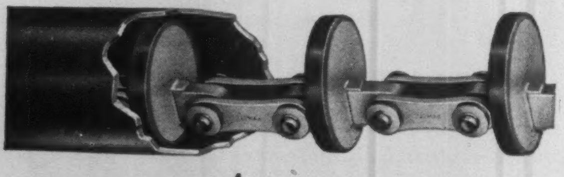

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. . . but return their cost many times. Sound engineering, superior materials and workmanship go into every Hapman installation. With Hapman tubular conveyors you have minimum wear, minimum degradation, and maximum trouble-free performance. This is why you may pay more initially, but with Hapman you can be sure of the best conveying system . . . and save in the long run.

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Circle 747 on Page 19

turing organization to proceed in its first line assembly only days behind the assembly and test of engineering models. This type of follow-up has been necessary in the fast turnover from tube to transistor machines in our industry.

I have spoken of one output from the records mechanization program, a set of instructions for an automatic assembly apparatus that does the wiring of the back panels. There are several parts of this apparatus. One part which can be used off-line cuts the wires to length and prepares the terminals. This can be done precisely because records mechanization prescribes how each of the interconnecting wires is to travel from one pin to the next, and thus dictates exactly how long it must be. More fundamentally, however, the mechanized equipment will take the wire, apply it to the terminals, automatically route it, and wire-wrap it with the other connection at the terminal of the wire. Such automatic assembly equipment is just beginning to be used by IBM Manufacturing. Its operation will greatly reduce the number of human errors associated with wiring the machines. Since every mistake in wiring must be found in final test, if not before, accuracy is most important.

Finally, the records furnish data which are used in the inspection of each assembled machine panel. Along with the special equipment designed by test equipment engineering, this goes a long way to guarantee that the wired machine with its hundreds of thousands of interconnections is as the design requires. Final assembly and test can thus proceed more efficiently.

It has been estimated that it would take approximately 50 hours of computer time to furnish a complete set of documents for a computer if the basic information were all correct and available at the beginning. It is impractical to estimate what the manual time would be to prepare the same information for today's machines, because it would not be possible to do all of the checking manually that can be done by machine. But for instance, just to prepare the wire lists from the logic pages, to permit wiring the panels of a typical machine, might take two man-years. To draw 1000 logic pages, approximately the number required for a modern machine, would take over six man-years. As has been previously stated, approximately four versions of each logic page are used for every final document issued. This indicates that the change activity can be very high in the early phases of design. In our laboratory we are designing so many machines that it is necessary to have a computation facility capable of handling nearly 5000 logic pages per month. This consumes the time of one IBM 704 and two IBM 705's along with much associated punched card equipment.

Data processing is greatly changing our engineering-manufacturing relationship. The impact is being felt in almost every aspect of manufacturing from materials control to manufacturing engineering and machine assembly. It has become a fundamental way of operating in IBM.

From a paper entitled "Data Processing of Engineering Information to Manufacturing," presented at 15th Annual Management Engineering Conference of the Society for Advancement of Management and the American Society of Mechanical Engineers, New York, April, 1960.

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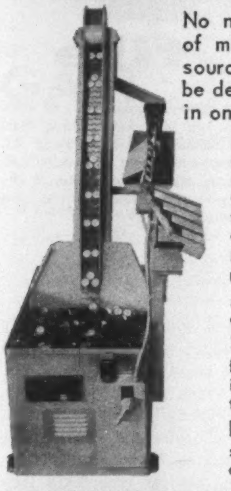

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Circle 748 on Page 19

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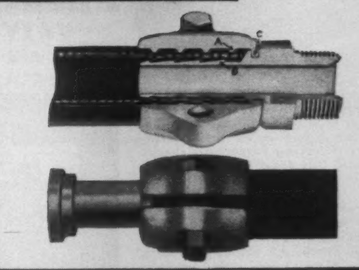

Only EASTMAN Clamp Couplings offer you the exclusive "Inter-Lock" feature shown in cutaway view above:

Outside rib of clamp locks in groove of hex (C) assuring precise positioning of each rib of clamp (A) between each barb of insert (B).

Because hose is uniformly compressed between alternating ribs and barbs, it cannot be weakened and will give your customers longer service.

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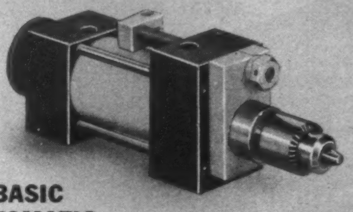

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Circle 751 on Page 19

Get Easier, More Accurate Cylinder Speed Control

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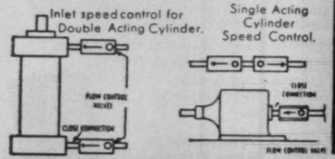
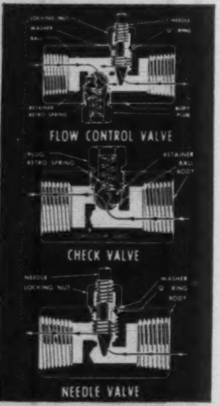

Inlet speed control for Double Acting Cylinder.
Single Acting Cylinder Speed Control.
FLOW CONTROL VALVES
CLOSE CONNECTION
CLOSE CONNECTION
FLOW CONTROL VALVE



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Circle 752 on Page 19

NEW JUNIOR SIZE VIBRA-WASHER

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READILY ADAPTABLE TO MANY OPERATIONS

NO NESTING OF PARTS DURING CLEANING OR CONDITIONING CYCLE

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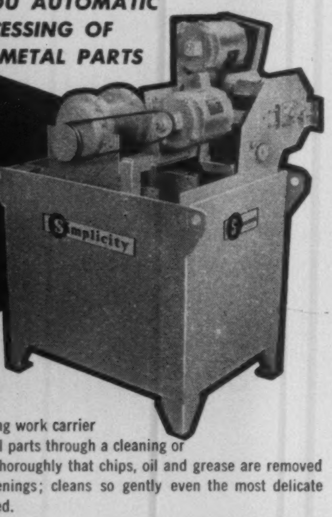

The new Simplicity Junior Size Vibra-Washer employs a vibrating work carrier that automatically conveys metal parts through a cleaning or conditioning bath. It cleans so thoroughly that chips, oil and grease are removed from even blind or slotted openings; cleans so gently even the most delicate threads or flanges are not harmed.

If you have a tough cleaning or conditioning job, Simplicity Engineering Company can help. For information, write or call the Industrial Washer Division.

223

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Circle 753 on Page 19

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2173-P

TYPE PRODUCTION

. . . I am interested in ideas and sources that can help solve a problem as to how to produce type and other non-resilient printing elements without engraving the characters. Our aim is to produce characters which are 0.046-inch deep, from face to field, and which are properly located on the type body. We produce a wide range of styles and sizes of type running from 4 points (0.055 inch) to 72 points (1 inch), although most of our requirements are for type 0.918 inch in height. Materials used are mostly steel and brass . . .

Methods Engineer

CASE 2175-P

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. . . I am interested in contacting a manufacturer of punched tape. I have a requirement for Mylar plastic tape 0.004 by ¼ inch with 1/16-inch holes punched down the tape centerline at ⅛-inch spacing. I would appreciate any help in locating a source. . .

Design Engineer

SUGGESTION FOR 2018-P (Mar. 1960)

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SUGGESTIONS FOR 2172-P (AUG. 1960)

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. . . We are sending copies of our Bulletin 2253 and price list, and ask that you send these on to your inquirer. We are certain that either our Filmeter or Magne-Gage will aid the plant superintendent. . .

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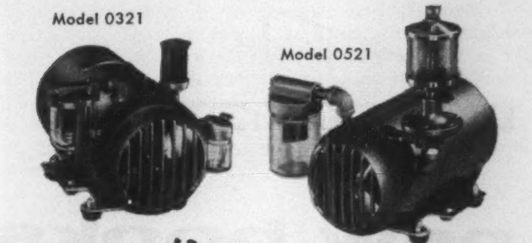
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Model 0521

GAST rotary vane AIR PUMPS

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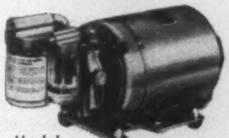
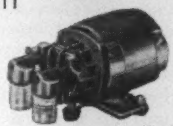

Model 0211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To reduce weight, save space and cut costs—use Gast Integral-Motor-Pump Models! Fitted for vacuum—or as air compressors. For oil-free air, some offered with oil-less construction. Very compact and dependable. Positive displacement.

Used as original equipment on instruments, test units, etc. Capacity from ½ to 3.8 cfm; to 28" vacuum or to 25 psi.

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- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

Circle 754 on Page 19

NEW DIXON AUTO-TORQUE *Driver*

SCREWS AND NUTS AUTOMATICALLY DRIVEN WITH PRECISE TORQUE CONTROL

Gives you . . .

1. Complete control of screws from parts feeder to chuck, until threads are started. No dependence on gravity to load chuck.
2. Exclusive built-in sensing, assures that screw is driven. Automatically retracts driver only after attaining proper torque.
3. Complete automatic cycle, requires only a touch of the pedal.
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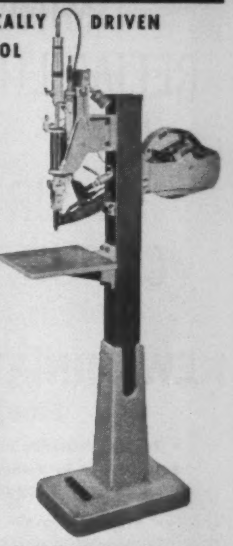
5. Clutch free-wheels after driving. Operator cannot vary the torque.
6. Two ranges of torque available 0 to 84 inch-pounds and 48 to 120.
7. Work height adjustment with 14" range, can be made without in any way disturbing the machine adjustments.

The new DIXON *Auto-Torque Driver* includes all the features of the DIXON Auto-Positioner, and has an efficient space-saving air motor with an adjustable-torque clutch. These features provide for *positive* handling, giving new efficiency in driving screws and nuts.


Model SD-100, above, tooled for any standard screw up to 5/16" thread size. Special tooled units with multiple feeders available. Model SD-101, without floor column, provides a complete automatic station. Maximum width 6 inches.

Full information available in bulletin No. SD-81.

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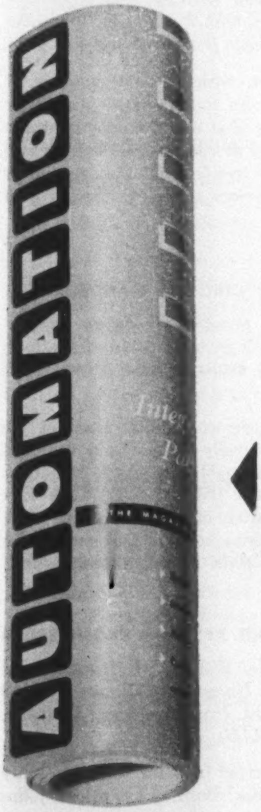

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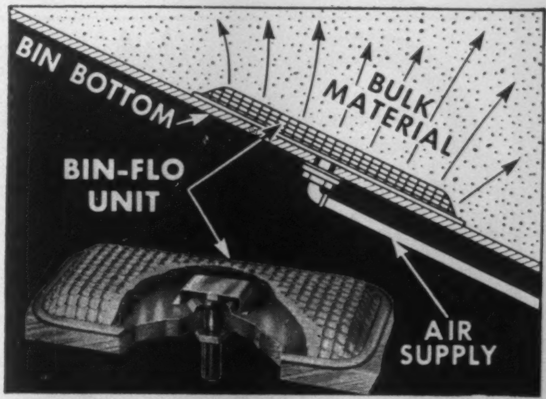

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AUTOMATION

new books

PRACTICAL CONTROL OF OFFICE COSTS

By H. B. Maynard, president, W. M. Aiken, vice president, and J. F. Lewis, senior consultant, H. B. Maynard & Co. Inc.; 160 pages, 8½ by 11 inches, published by Management Publishing Corp., Greenwich, Conn.; available from AUTOMATION; $12.75.

Continuing expansion of office work forces has created interest in the possibility of applying standard time values to office type tasks in order to measure individuals' performances. The authors discuss a technique that they have used for a period of years for just such a purpose. The subject matter is related to automation in that it is important that a justification study, preceding the introduction of an automated data handling system, compare a proposed machine system to the most efficient manual system which might be obtained.

FUNDAMENTALS OF TRANSISTOR PHYSICS

By Irving Gottlieb, professional engineer; 146 pages, 5½ by 8½ inches, paperbound, published by John F. Rider Publisher Inc., New York; available from AUTOMATION; $3.90.

Book is designed for readers, with an understanding of vacuum-tube practices, who desire to familiarize themselves with the field of transistors. To that end the underlying approach is to present the analogy of vacuum-tube circuits and principles to the application of transistors. A special chapter is devoted to semiconductor devices related to the junction transistor.

SELECTED SEMICONDUCTOR CIRCUITS HANDBOOK

Edited by Seymour Schwartz, president, Transistor Applications Inc.; 503 pages, 5¾ by 9 inches, published by John Wiley & Sons Inc., New York; available from AUTOMATION; $12.00.

Representing the work of eight co-authors, much of the material in the book was originally written and compiled for the Dept. of the Navy and published as "A Handbook of Selected Semiconductor Circuits (NObsr 75231). The book presents to a designer a large variety of reliable building block circuits along with general information that will enable him to obtain different circuits to meet his requirements.

OPERATIONS RESEARCH AND SYSTEMS ENGINEERING

Edited by Charles D. Flagle, William H. Huggins, and Robert H. Roy, Johns Hopkins University; 889 pages, 6 by 9 inches, published by the Johns Hopkins Press, Baltimore; available from AUTOMATION; $14.50.

Chapters in this book are derived from the work of twenty lecturers at an annual two-week course presented at Johns

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Hopkins University for management level personnel. The strength of the work appears to be in the very readable manner in which it touches upon all of the varied aspects of operations research and systems engineering. Typically, the various chapters present examples or case histories to illustrate the phase being discussed; the illustrative material tends to lack the manufacturing orientation that an industrial reader might prefer.

Industrial Publications

TECHNIQUES OF PLANT MAINTENANCE AND ENGINEERING—VOL. XI

Available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.; clothbound, 341 pages, 8¼ by 11 inches, $10.00.

Report of the proceedings of the technical sessions held concurrently with 1960 National Plant Maintenance and Engineering Show. Various papers are illustrated with charts, graphs, and reproductions of administrative forms. As with previous volumes, the report includes a transcript of the question and answer period that followed presentation of each of the papers.

FUNDAMENTALS OF VACUUM HEAT TREATING

Available from Ipsen Industries Inc., 715 South Main St., Rockford, Ill.: looseleaf binding, 47 pages, 8½ by 11 inches, illustrated; $2.00.

This manual covers basic considerations that apply to vacuum heat treating furnaces and to the use of such furnaces. A section on vacuum heat treating practices includes a discussion of annealing and outgassing, hardening, tempering, sintering, and brazing.

CONTROLLED RECTIFIER MANUAL

Available from General Electric Co., Dept. SCR, Charles Bldg., Liverpool, New York; looseleaf binding, 224 pages, 5½ by 8½ inches, illustrated; $1.00.

Manual was written by five application engineers in General Electric's Semiconductor Products Dept. and is based upon their experiences in aiding customers to apply silicon controlled rectifiers in circuits. Included in the manual is information on voltage transients in SCR circuits, test circuits, turn-off characteristics and methods, firing characteristics and circuits, and series and parallel operation of SCRs.

Association Publication

BIBLIOGRAPHY FOR OFFICE MANAGEMENT

Available from National Office Management Association, Willow Grove, Pa.; looseleaf binding, 74 pages, 8½ by 11 inches; $5.00.

As a convenient guide to current material published on office management subjects, the bibliography includes references to over 550 magazine articles and 70 books published during the period May 1959 through April 1960. It also includes a listing of films which have been made available by various companies and organizations.

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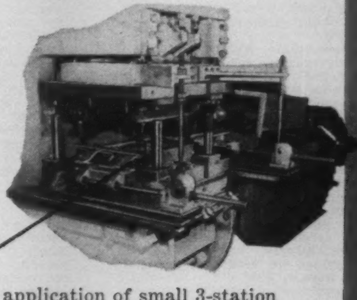

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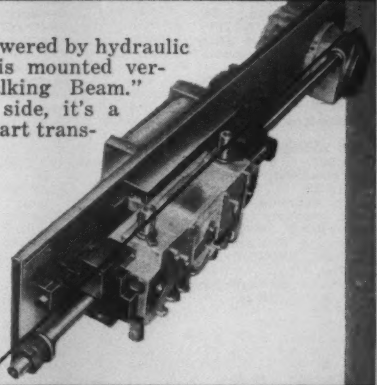

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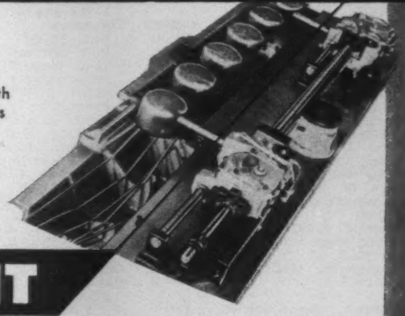

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Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

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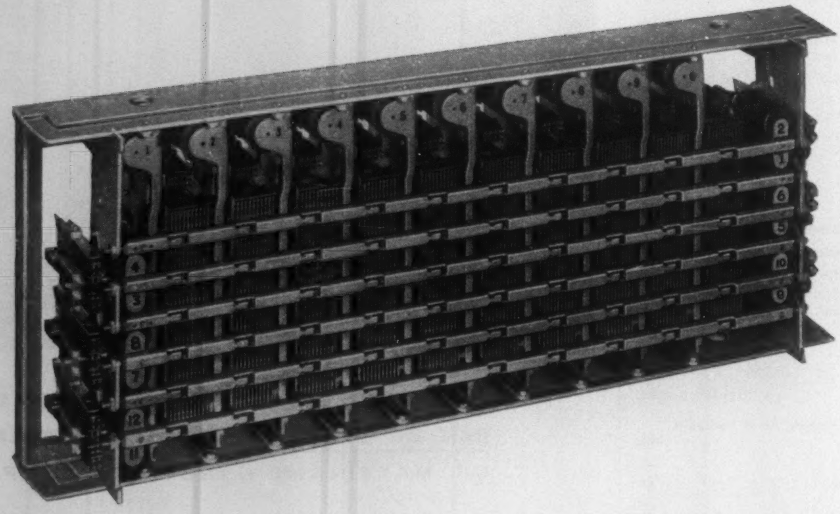

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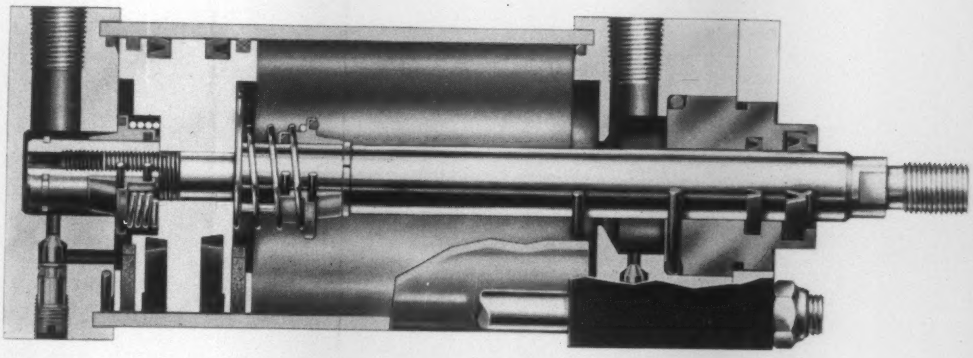

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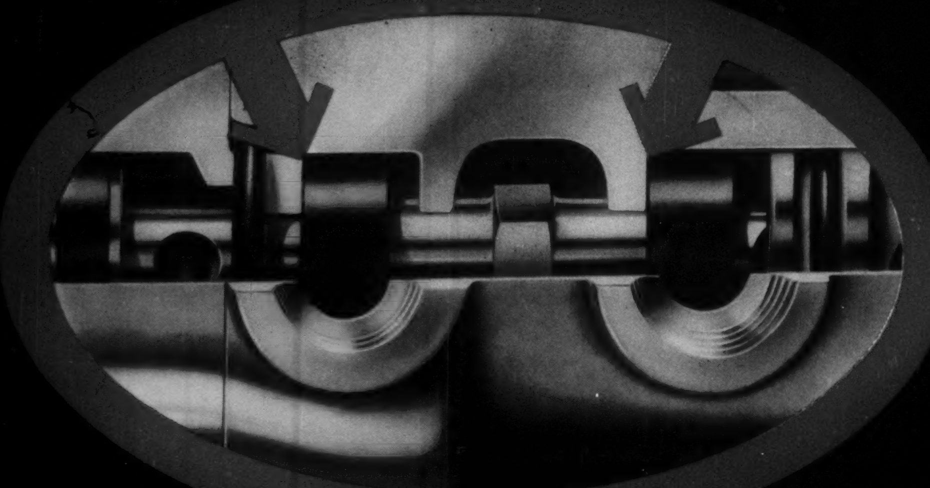

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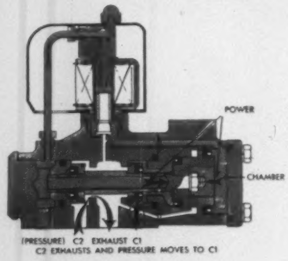
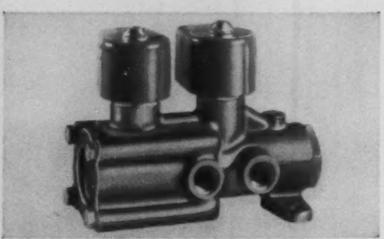
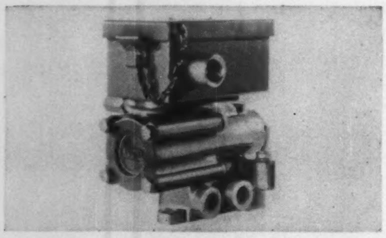


Operation: ASCO Single Solenoid 4-way Valves are power-driven in both directions by line pressure. When the solenoid is de-energized, line pressure applied to the top of the piston core forces it off the seat, eliminating possible sticking due to residual magnetism. Line pressure is applied to Chamber A, moving the piston-disc assembly to the left. When the solenoid is energized, Chamber A is exhausted and line pressure drives the piston to the right. Single solenoid type (illustrated) operates when solenoid is energized; returns automatically when de-energized.



Dual Solenoid (Bulletin 8344): operates when either solenoid is energized; will not return until opposite solenoid is energized (single solenoid types return when de-energized). In dual solenoid valves, solenoids may be energized continuously or momentarily.



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